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AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

YEAR-BOOK 1911

CONTAINING THE

STANDARD SPECIFICATIONS

AND

List of Members and Technical Committees, and other Information concerning the American Society for Testing Materials and the International Association for Testing Materials.

EDITED BY THE SECRETARY, UNDER THE DIRECTION OF THE COMMITTEE ON PUBLICATIONS.

OFFICE OF THE SECRETARY, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.
PUBLISHED BY THE SOCIETY.
1911.

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Oct 17, 1911
HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING.
(1911)

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CHARTER

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS

To the Honorable the Judges of the Court of Common Pleas No. 2 in and for the City and County of Philadelphia: of March Term, 1902, No. 2056:

In compliance with the requirements of an Act of the General Assembly of the Commonwealth of Pennsylvania, entitled "An Act to Provide for the Incorporation and Regulation of Certain Corporations," approved the 29th day of April, A.D. one thousand eight hundred and seventy-four, and the supplements thereto, the undersigned, Henry M. Howe, Charles B. Dudley, Edgar Marburg, Robert W. Lesley, Mansfield Merriman, Albert Ladd Colby and William R. Webster, six of whom are citizens of Pennsylvania, having associated themselves together for the purposes hereinafter set forth, and desiring that they may be incorporated according to law, do hereby certify:

1. The name of the proposed corporation is the "AMERICAN SOCIETY FOR TESTING MATERIALS."

2. The corporation is formed for the Promotion of Knowledge of the Materials of Engineering, and the Standardization of Specifications and the Methods of Testing.

3. The business of the said corporation is to be transacted in Philadelphia.

4. The said corporation is to exist perpetually.

5. The names and residences of the incorporators are as follows:

HENRY M. HOWE, 27 West Seventy-third Street, New York.
CHARLES B. DUDLEY, Altoona, Pa.
EDGAR MARBURG, 517 South Forty-first Street, Philadelphia.
ROBERT W. LESLEY, 22 South Fifteenth Street, Philadelphia.
MANSFIELD MERRIMAN, South Bethlehem, Pa.
ALBERT LADD COLBY, South Bethlehem, Pa.
WILLIAM R. WEBSTER, "The Bartram," Thirty-third and Chestnut Streets, Philadelphia.

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6. The management of the said corporation shall be vested in an Executive Committee, consisting of six (6) members, viz.: the Chairman, the Vice-Chairman, the Secretary, the Treasurer and two other members of the corporation, and such other officers as the corporation may from time to time appoint.

7. The corporation has no capital stock, and the members thereof shall be composed of the subscribers and their associates and of such persons as may from time to time be admitted by vote in such manner and upon such requirements as may be prescribed by the By-Laws. The corporation shall nevertheless have power to exclude, expel or suspend members for just or legal cause, and in such legal manner as may be ordained and directed by the By-Laws.

8. The By-Laws of this corporation shall be admitted and taken to be its laws subordinate to the statute aforesaid; this Charter; Constitution and Laws of the Commonwealth of Pennsylvania, and the Constitution of the United States; they shall be altered and amended as provided for by the By-Laws themselves; and shall prescribe the powers and functions of the Executive Committee herein mentioned and those to be hereafter elected, the times and places of meetings of the Committee and this corporation; the number of members who shall constitute a quorum at the meetings of the corporation, and of the Committee; the qualifications and manner of electing members; the manner of electing officers; and the powers and duties of such officers; and all other concerns and internal arrangements of the said corporation.

Witness our hands and seals this twenty-first day of March, A.D. 1902.

(Signed) EDGAR MARBURG,
R. W. LESLEY,
WM. R. WEBSTER,
MANSFIELD MERRIMAN,
ALBERT LADD COLBY.

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BY-LAWS

ARTICLE I.

MEMBERS.

SECTION 1. The Society shall consist of Members and Junior Members.

SEC. 2. A Member shall be a person not less than thirty years of age, corporation, firm, technical society, teaching faculty or library, proposed by two members and approved by the Executive Committee.

SEC. 3. A Junior Member shall be a person less than thirty years of age on the date of his admission, proposed by two members and approved by the Executive Committee. A Junior Member shall have the same rights and privileges as a Member, and his status shall be changed from that of Junior Member to Member at the beginning of the fiscal year next succeeding the date on which he attains the age of thirty years.

SEC. 4. Applications for membership and resignation from membership must be transmitted in writing to the Secretary.

ARTICLE II.

OFFICERS AND THEIR ELECTION.

SECTION 1. The officers shall be a President, Vice-President, Secretary and Treasurer.

SEC. 2. The offices of Secretary and Treasurer shall be held by the same person.

SEC. 3. These officers shall be elected by letter ballot, at the Annual Meeting, and shall hold office for two years.

SEC. 4. The Executive Committee shall consist of these officers and also the last Past President and seven members, four being elected by letter ballot at each Annual Meeting in the odd years and three at each Annual Meeting in the even years. Four members of the Executive Committee shall constitute a quorum.

SEC. 5. The President shall be, *ex officio*, the nominee for American Member of the Council of the International Association.

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SEC. 6. The Secretary shall receive a salary to be fixed by the Executive Committee.

SEC. 7. The officers and members of the Executive Committee shall serve for the respective terms to which they shall have been elected, or until their successors shall have been duly elected.

SEC. 8. The Executive Committee shall have the power to fill any vacancies occurring in their number by death, resignation or otherwise.

SEC. 9. The election of officers and members of the Executive Committee shall be by letter ballot. The Executive Committee, before each Annual Meeting, shall appoint a Nominating Committee, whose duty it shall be to nominate a full list of officers. The list of nominations so made shall be submitted to the membership not more than eight (8) nor less than four (4) weeks before the coming Annual Meeting.

Further nominations, signed by at least ten (10) members, may be submitted to the Secretary in writing at least four (4) weeks before the Annual Meeting, and such nominations shall also be submitted to the membership on the official ballot.

ARTICLE III.

MEETINGS.

SECTION 1. The Society shall meet annually. The time and place of each meeting shall be fixed by the Executive Committee.

SEC. 2. Special meetings may be called whenever the Executive Committee shall deem it necessary, or upon the request in writing to the President of twenty-five (25) members.

ARTICLE IV.

PROCEDURE GOVERNING THE ADOPTION OF STANDARD SPECIFICATIONS.

SECTION 1. A proposed standard specification must be presented at the Annual Meeting, at which it may be amended by majority vote of those voting. A two-thirds affirmative vote of those voting shall be required to refer the specification to letter

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ballot of the Society. A two-thirds affirmative vote of those voting on letter ballot shall be required for the adoption of the specification.

ARTICLE V.

DUES.

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

SEC. 2. Members or Junior Members holding membership also in the International Association for Testing Materials shall pay annually, in advance, the additional sum of $2.00, the fiscal year of the International Association beginning on the first of January, which sum shall be transmitted by the Treasurer to the International Association.

SEC. 3. Any Member or Junior Member may compound his dues at the beginning of any fiscal year by the purchase of a life membership, exempting him for life from annual dues, by the payment of the sum of one hundred and fifty dollars ($150); provided such membership is held by an individual. The cost of life membership, or membership in perpetuity, to corporations, firms, technical societies, teaching faculties or libraries shall be two hundred dollars ($200).

SEC. 4. Any member of the Society whose dues shall remain unpaid for a period of three months from the beginning of the fiscal year shall receive a "Second Notice" from the Treasurer; if his dues shall remain unpaid for a period of five months from the beginning of the fiscal year, he shall forfeit the right to vote and to receive the publications of the Society. A month before the close of the fiscal year, he shall receive a final notice from the Treasurer that, if he neglects to pay his dues before the end of the fiscal year, his name may be stricken from the roll of membership by the Executive Committee.

SEC. 5. Any person elected after six months of any fiscal year shall have expired, shall pay only one-half of the amount of dues for that fiscal year; but he shall not be entitled to a copy of the Proceedings of the previous Annual Meeting.

SEC. 6. The resignation of a member whose dues for the current fiscal year are unpaid, shall be acceptable only if it be received within one month from the beginning of the fiscal year, unless an exception be authorized by special action of the Executive Committee.

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ARTICLE VI.

AMENDMENTS.

SECTION 1. Proposed amendments to these By-Laws, signed by at last three members, must be presented in writing to the Executive Committee at least four weeks before the next Annual Meeting. In the notices for this meeting the proposed amendments shall be printed. At the Annual Meeting the proposed amendment may be discussed and amended and may be passed to letter ballot by a two-thirds vote of those present.

If two-thirds of the votes obtained by letter ballot are in favor of the proposed amendment, it shall be adopted.

SEC. 2. The Executive Committee is authorized to number the Articles and Sections of the By-Laws to correspond with any changes that may be made.

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GENERAL INFORMATION.

International Association for Testing Materials.

Historical.—The International Association for Testing Materials had its origin in a conference of a small group of workers in experimental engineering held in Munich in 1882, at the instance chiefly of the late John Bauschinger. Meetings on a larger scale were subsequently held in Dresden (1884), Berlin (1886), Munich (1888), Vienna (1893), and Zurich (1895). At the Zurich Congress the International Association for Testing Materials was formally organized, the Second Congress was held at Stockholm in 1897, the Third Congress met at Budapest in 1901, the Fourth Congress met at Brussels in 1906, and the Fifth Congress met at Copenhagen in 1909. The Sixth Congress will be held in the United States during the first half of September, 1912, on dates not yet definitely determined.

Membership.—According to the latest official report (May, 1911), the membership is distributed as follows:

United States	*465	Hungary	98	Japan	10
Germany	399	Spain	90	Luxembourg	9
Russia (Finland, 32)	293	Switzerland	84	Canada	8
Austria	220	Italy	64	Chili	5
France	198	Sweden	64	Brazil	4
Denmark	170	Holland	50	Panama	3
Great Britain	140	Norway	50	Servia	2
Belgium	110	Australia	27	Argentine Republic	1
		Roumania	22	Greece	1
		Portugal	11		

Total (representing 27 countries) 2,598

Objects.—The objects of the Association, as set forth in its by-laws†, are: "The development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for this purpose." The important subject of specifications has, however, also been included more recently within the scope of the Association's activity.

*The American membership is now (September, 1911) 492.

†These by-laws are given in full on pp. 327-330.

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Administration.—The affairs of the Association are administered by a Council, consisting of the President and one representative (member of Council) from each country having a membership of twenty or more.

Methods.—The original plan was to conduct investigations almost exclusively through the agencies of international committees. These committees proved unwieldly, however, by reason of their large membership, with the added difficulties arising from geographical separation and differences of language. In pursuance of resolutions at the Budapest Congress (1901) the Council has discharged some of these committees, re-assigning the problems in part to individual referees.* In the case of questions of direct international concern, the original international committees are continued. At the International Congresses the reports of these committees as well as individual contributions by members are presented and discussed.

Publications.—The publications of the International Association consist of Proceedings, issued in pamphlet form at irregular intervals during the year, of which the first number was published in May, 1908, and the last to date, No. 4, Vol. II, in May, 1911. These Proceedings are printed in German, English and French, and contain the papers and committee reports presented at the International Congresses, the minutes of the Council, official communications, membership lists, personnel of technical committees, etc.†

ORGANIZATION OF THE AMERICAN MEMBERS OF THE INTERNATIONAL ASSOCIATION.

Historical.—With a view of bringing the members of like nationality into closer relations among themselves, and in order to simplify the management and render the work of the International Association more effective, it was decided at the Stockholm

*For a complete list of technical problems, committees and referees, see pp. 331-337.

† The Proceedings of the Fifth Congress, held at Copenhagen in 1909, are contained in pamphlets Nos. 5-15 incl., the contents aggregating about 1,000 pages. Copies of the English edition of these Proceedings, bound in cloth, may be obtained at the price of $5.00 per volume from the McGraw-Hill Book Company, American agents for the publications of the International Association, 239 West Thirty-ninth Street, New York.

The papers presented at the Brussels Congress, 1906, may be obtained at the following prices:

Official Papers, per set..... .....$1.50
Non-Official Papers, per set..... 2.50
Separate copies of above papers, 10-20 cents.

A list of these official and non-official papers may be had by addressing: Edgar Marburg. University of Pennsylvania, Philadelphia.

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Congress (1897) to encourage the consolidation of the membership in the various countries into separate national organizations. In pursuance of this action the American members met in Philadelphia on June 16, 1898, and organized under the name of the "American Section of the International Association for Testing Materials."

In March, 1902, the Executive Committee of the American Section applied for a Charter under the laws of the State of Pennsylvania for purposes of incorporation under the proposed new name of the "American Society for Testing Materials." This Charter was duly granted, and at the Fifth Annual Meeting, held at Atlantic City, N. J., it was unanimously adopted on June 12, 1902.

At the Eighth Annual Meeting (1905), the by-laws were amended with a view of leaving membership in the International Association to the individual option of the members of the American Society. This amendment was adopted by letter ballot of the Society.

Objects.—The objects of the Society are essentially identical with those of the International Association, with which it stands in direct organic relation, both through its membership in the same as a body, and through the individual membership on the part of many of its members.

As stated in the Charter: "The corporation is formed for the promotion of knowledge of the materials of engineering, and the standardization of specifications and the methods of testing."

The standardization of specifications is considered one of the most important functions of the Society. The method of procedure is to submit proposed standard specifications prepared by the various committees for general discussion at the annual meetings of the Society. The specifications in their original or amended form may then be referred, by two-thirds vote of those voting, to letter ballot of the Society subject to adoption as Standard Specifications by two-thirds vote of those voting. A list of the Standard Specifications thus far adopted by the Society is given on pages 16-21.

Representation on the International Council.—The American members are entitled to one representative on the International Council. By the By-Laws of the Association (1909) · "Every country represented in the Association by at least twenty members has the right to elect one member as member of the Council." According to the By-Laws of the American Society, the President is "*ex officio*" the American Member of the Council of the International Association.

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Meetings.—The Society meets annually at a time and place fixed by the Executive Committee. Special meetings may also be called in accordance with the provisions of the by-laws.

Membership.—The number of American members at the time of the organization meeting in 1898 was 70. The membership reported at the successive annual meetings was as follows: (1899) 128, (1900) 160, (1901) 168, (1902) 175, (1903) 349, (1904) 485, (1905) 677, (1906) 835, (1907) 925, (1908) 1,015, (1909) 1,160, (1910) 1,280, (1911) 1,382.

Methods.—The operations of the Society are conducted in part under the auspices of the International Association, but for the most part independently.

The number of American representatives on international committees is fixed by the International Council. These American sub-committees are authorized, however, to increase their number, at pleasure, subject always to the approval of the Executive Committee of the American Society. The sense of these enlarged sub-committees on all questions is determined by majority vote; but on the international committees the representation and the number of votes allowed remain as originally fixed by the International Council.

The American Society appoints other committees at its discretion entirely independently of the International Association. On committees .concerned with subjects involving commercial interests, the policy is to accord equal numerical representation to engineers or scientists, and to manufacturers.

Many of these committees have rendered a useful service in the origination of proposed standard specifications for materials and for methods of testing. Such proposed specifications on approval by majority vote of the committees concerned are submitted to the Society at its annual meetings, when the specifications may be discussed, amended, and referred to letter ballot of the Society by two-thirds vote of those voting. The final adoption of the specifications by letter ballot is contingent on an affirmative two-thirds vote of those voting.

The personnel of the Technical Committees of the American Society is indicated on pages 310-322.

Publications.—The publications of the Society appeared originally at irregular intervals in the form of bulletins. Twenty-eight bulletins, containing a total of 266 pages, were thus issued. Since 1902 the Proceedings have appeared in the form of annual volumes. In passing to this new plan of publication the twenty-eight bulletins previously issued were counted collectively as

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Volume I. The Table of Contents of all publications issued by the Society, with price list, is given on pages 367-385.

In 1910, the Society began the publication of a Year-Book containing all the standard specifications in their latest revised form, besides the by-laws, list of members, committees, and other information concerning the Society. Each standard specification is also published in separate form. The price list for the Year-Book and for the separate specifications is given on page 21.

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LIST OF STANDARD SPECIFICATIONS

ADOPTED BY THE

AMERICAN SOCIETY FOR TESTING MATERIALS

These standard specifications are all copyrighted in the name of the American Society for Testing Materials. Permission to reprint any of these specifications can be obtained only from the Executive Committee on application to the Secretary.

A. FERROUS METALS.

1. Standard Specifications for Bessemer Steel Rails.*
   Proposed May, 1900 (Vol. I, pp. 101-105).
   Adopted in amended form August 10, 1901 (Vol. I, p. 253).
   First revision adopted September 1, 1907 (Vol. VII, pp. 44-47).
   Second revision adopted August 15, 1908 (Vol. VIII, pp. 44-47).
   Third revision adopted August 16, 1909 (Vol. IX, pp. 62-65).

2. Standard Specifications for Open-Hearth Steel Rails.
   Proposed June, 1909.
   Adopted August 16, 1909 (Vol. IX, pp. 66-69).

3. Standard Specifications for Steel Splice Bars.
   Proposed May, 1900 (Vol. I, pp. 107-109).
   Adopted in amended form August 10, 1901 (Vol. I, p. 253).
   First revision adopted August 16, 1909 (Vol. IX, pp. 56-57).

4. Standard Specifications for Structural Steel for Bridges.†
   Proposed May, 1900 (Vol. I, pp. 81-86).
   Adopted in amended form August 10, 1901 (Vol. I, p. 250).
   First revision adopted September 1, 1905 (Vol. V, pp. 48-52).
   Second revision adopted August 16, 1909 (Vol. IX, pp. 37-41).

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* These specifications were designated "Standard Specifications for Steel Rails," till the adoption, August 16, 1909, of separate "Standard Specifications for Open-Hearth Steel Rails."

† These specifications, when first adopted in 1901, were combined with the Specifications for Structural Steel for Ships under the title "Standard Specifications for Structural Steel for Bridges and Ships." In 1905, these latter specifications were made to apply to ship material only, by striking out the words "*Bridges and*" from the title, and revised "Standard Specifications for Structural Steel for Bridges" were adopted.

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5. Standard Specifications for Structural Steel for Buildings.
   Proposed May, 1900 (Vol. I, pp. 87-92).
   Adopted in amended form August 10, 1901 (Vol. I, p. 250).
   First revision adopted August 16, 1909 (Vol. IX, pp. 47-50).

6. Standard Specifications for Structural Steel for Ships.*
   Proposed May, 1900 (Vol. I, pp. 81-86).
   Adopted in amended form August 10, 1901 (Vol. I, p. 250).
   First revision adopted August 16, 1909 (Vol. IX, pp 42-46).

7. Standard Specifications for Steel Axles.
   Proposed May, 1900 (Vol. I, pp. 111-114).
   Adopted in amended form August 10, 1901 (Vol. I, p. 254).
   First revision adopted September 1, 1905 (Vol. V, pp. 56-58).

8. Standard Specifications for Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts.
   Proposed June, 1911.
   Adopted August 21, 1911 (Vol. XI, pp. —).

9. Standard Specifications for Steel Tires.
   Proposed May, 1900.
   Adopted August 10, 1901 (Vol. I, pp. 115-118).
   First revision adopted August 16, 1909 (Vol. IX, pp. 58-61).

10. Standard Specifications for Steel Forgings.
    Proposed May, 1900 (Vol. I, pp. 119-123).
    Adopted in amended form August 10, 1901 (Vol. I, p. 254).
    First revision adopted September 1, 1905 (Vol. V, pp. 59-62).

11. Standard Specifications for Steel Castings.
    Proposed May, 1900.
    Adopted August 10, 1901 (Vol. I, pp. 125-128).
    First revision adopted September 1, 1905 (Vol. V, pp. 53-55).

12. Standard Specifications for Steel Reinforcement Bars.
    Proposed June, 1911.
    Adopted August 21, 1911 (Vol. XI, pp. —).

13. Standard Specifications for Open-Hearth Boiler Plate and Rivet Steel.
    Proposed May, 1900 (Vol. I, pp. 93-99).
    Adopted in amended form August 10, 1901 (Vol. I, p. 251).
    First revision adopted August 16, 1909 (Vol. IX, pp. 51-55).

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*See Standard Specifications for Structural Steel for Bridges.

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14. Standard Specifications for Wrought Iron.
Proposed May, 1900 (Vol. I, pp. 129-134).
Adopted in amended form August 10, 1901 (Vol. I, pp. 231-235). See also Vol. I, p. 254.

15. Standard Specifications for Staybolt Iron.
Proposed June, 1907 (Vol. VII, pp. 157-158).
Adopted in amended form September 1, 1910 (Vol. X, pp. 94–95).

16. Standard Specifications for Foundry Pig Iron.
Proposed June, 1904 (Vol. IV, p. 44).
Adopted in amended form November 15, 1904 (Vol. IV, pp. 103-104).
First revision adopted August 16, 1909 (Vol. IX, pp. 111-112).

17. Standard Specifications for Cast-Iron Pipe and Special Castings.
Proposed June, 1904.
Adopted November 15, 1904 (Vol. IV, pp. 57-66).

18. Standard Specifications for Locomotive Cylinders.
Proposed June, 1904 (Vol. IV, pp. 69-70).
Adopted in amended form November 15, 1904 (Vol. IV, p. 69).
Revised specifications proposed June, 1911 (Vol. XI, pp. —).

19. Standard Specifications for Cast-Iron Car Wheels.
Proposed June, 1904 (Vol. IV, pp. 74-79).
Adopted in amended form September 1, 1905 (Vol. V, pp. 65-70).

20. Standard Specifications for Gray-Iron Castings.
Proposed June, 1904 (Vol. IV, pp. 97-100).
Adopted in amended form September 1, 1905 (Vol. V, pp. 71-74).

21. Standard Specifications for Malleable Castings.
Proposed June, 1904 (Vol. IV, pp. 95-96).
Adopted in amended form November 15, 1904 (Vol. IV, p. 96).

22. Recommended Practice for Annealing Miscellaneous Rolled and Forged Carbon-Steel Objects.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

23. Standard Magnetic Tests of Iron and Steel.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

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B. NON-FERROUS METALS.

24. Standard Specifications for Hard-Drawn Copper Wire.
Proposed June, 1909.
Adopted August 16, 1909 (Vol. IX, pp. 311-318).
First revision adopted August 21, 1911. (Vol. XI, pp. —).

25. Standard Specifications for Copper-Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

26. Standard Specifications for Spelter.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

27. Standard Specifications for Manganese-Bronze Ingots.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

C. CEMENT AND CLAY PRODUCTS.

28. Standard Specifications for Cement.
Proposed June, 1904.
Adopted November 15, 1904 (Vol. IV, pp. 105-119).
First revision adopted August 15, 1908 (Vol. VIII, pp. 149-164).
Second revision adopted August 16, 1909 (Vol. IX, pp. 116-130).

29. Standard Test for Fireproof Floor Construction.
Proposed June, 1906 (Vol. VI, pp. 126-128).
Adopted September 1, 1907 (Vol. VII, pp. 179-180).
First revision adopted August 15, 1908 (Vol. VIII, pp. 210-212).

30. Standard Test for Fireproof Partition Construction.
Proposed June, 1908 (Vol. VIII, pp. 207-209).
Adopted August 16, 1909 (Vol IX, pp. 281-282).

D. MISCELLANEOUS MATERIALS.

31. Standard Abrasion Test for Road Material.
Proposed June, 1904 (Vol. IV, pp. 193-194).
Adopted August 15, 1908 (Vol. VIII, pp. 197-198).

32. Standard Toughness Test for Macadam Rock.
Proposed June, 1905 (Vol. V, pp. 102-103).
Adopted August 15, 1908 (Vol. VIII, pp. 199-200).

33. Provisional Method for the Determination of Soluble Bitumen.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

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34. Provisional Method for the Determination of the Penetration of Bitumen.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

35. Provisional Method for the Determination of the Loss on Heating of Oil and Asphaltic Compounds.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

36. Provisional Method of Sizing and Separating the Aggregate in Asphalt Paving Mixtures.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).

37. Standard Classification of Structural Timber.*
I. Definition of Structural Timber.
II. Standard Defects.
III. Standard Names for Structural Timber.
Proposed June, 1906 (Vol. VI, pp. 129-133).
Adopted in amended form September 1, 1907 (Vol. VII, pp. 187-192).

38. Standard Specifications for Yellow-Pine Bridge and Trestle Timbers.
Proposed June, 1909 (Vol. IX, pp. 283-286).
Adopted September 1, 1910 (Vol. X, pp. 159–161).

E. MISCELLANEOUS SUBJECTS.

39. Standard Methods of Testing.
I. Methods for Tensile Tests of Metals.
II. Methods for Compressive Tests of Metals.
I and II: Proposed June, 1909 (Vol. IX, pp. 263–270).
Adopted September 1, 1910.
III. Methods for Transverse Tests of Metals.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. —).
IV. Methods for Metallographic Tests of Metals.
Proposed June, 1909 (Vol. IX, pp. 270-272).
Adopted September 1, 1910.

* These specifications originally included "Standard Specifications for Bridge and Trestle Timbers," and were designated "Standard Specifications for Structural Timber" till the adoption, September 1, 1910, of separate "Standard Specifications for Yellow-Pine Bridge and Trestle Timbers."

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PRICE LIST OF STANDARD SPECIFICATIONS.

The prices of the above Standard Specifications are as follows:

Single copies						25	cents.
For lots of	10	to	25			20	cents each.
" " "	25	"	100			15	" "
" " "	100	"	500			10	" "
" " "	500	"	1,000			7½	" "
" " "	1,000	and	over			5	" "

Since the numeric designation of the Standard Specifications is subject to change from year to year, specifications should be ordered by title and not by number.

Members of the Society may obtain extra copies of the Standard Specifications at the following prices:

Single copies	15 cents.
For lots of 10 to 100	10 cents each.
Lots above 100, as per price list above.	

The price of the Year-Book in cloth binding containing all the Standard Specifications in their latest revised form is $5.00. Members of the Society may obtain the Year-Book at the special price of $3.00. Libraries, publishers and book-dealers are allowed a discount of 20 per cent.

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No. 2 Rails. 11. No. 2 rails will be accepted to at least 5 per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

Inspection. 12. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel for each day and night turn. Analyses shall be made on drillings taken from small test ingots, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of said test ingots. On request of the inspector the manufacturer shall furnish drillings for check analysis.

The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the rails are being made in accordance with the terms of the contract. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR BESSEMER STEEL RAILS.

ADOPTED AUGUST 16, 1909.

Process of Manufacture.

1. (*a*) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(*b*) Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled or until the metal in the interior has time to solidify.

(*c*) No bled ingots shall be used.

(*d*) There shall be sheared from the end of the blooms formed from the top of the ingots not less than x per cent.,* and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 60 lbs. Per cent.	61 to 70 lbs. Per cent.	71 to 80 lbs. Per cent.	81 to 90 lbs. Per cent.	91 to 100 lbs. Per cent.
Carbon	0.35-0.45	0.35-0.45	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus, not over	0.10	0.10	0.10	0.10	0.10
Silicon, not over	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.84-1.14

*The percentage of minimum discard in any case to be subject to agreement, and it should be recognized that the higher this percentage the greater will be the cost.

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For each decrease of 0.003 per cent. in phosphorus down to 0.03 per cent. phosphorus, an increase of 0.01 per cent. carbon will be accepted.

Shrinkage. 3. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of rails of sections 75 lbs. per yard and heavier will not exceed that which requires a shrinkage allowance at the hot saws of $6\frac{7}{16}$ ins. for a 33-ft. 75-lb. rail, with an increase of $\frac{1}{16}$ in. for each increase of 5 lbs. in the weight of the section.

No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Drop Test. 4. One drop test may be made on a piece of rail not less than 4 ft. and not more than 6 ft. long, selected from each heat of steel.

The rails shall be placed head upward on the supports and the various sections shall be subjected to the following impact tests under a free falling weight:

Weights of rail per yard.	Height of drop in feet.
50 to 60 lbs.	15
61 to 70 lbs.	16
71 to 80 lbs.	16
81 to 90 lbs.	17
91 to 100 lbs.	18

If any rail breaks when subjected to the drop test, two additional tests will be made of other rails from the same heat of steel, and if either of these latter tests fail, all the rails of the heat which they represent will be rejected; but if both of these additional test pieces meet the requirements all the rails of the heat which they represent will be accepted.

Drop-Testing Machine. The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made. The temperature of the test pieces, when tested, shall be not less than 60° F. or greater than 120° F. The testing shall proceed concurrently with the operation of the mill.

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Weight and Section.

5. Unless otherwise specified, the section of rail shall be the American standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with Paragraph 6, relative to specified weight. A variation in height of $\frac{1}{64}$ in. less, or $\frac{1}{32}$ in. greater than the specified height, and $\frac{1}{16}$ in. in width will be permitted.

6. The weight of the rails will be maintained as nearly as possible, after complying with Paragraph 5, to that specified in the contract. A variation of one-half of 1 per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

Length.

7. The standard length of rails shall be 30 or 33 feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 feet. A variation of $\frac{1}{4}$ in. in length from that specified will be allowed.

Both ends of all short-length No. 1 rails shall be painted green.

8. Circular holes for splice bolts shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished, and must be free from burrs.

Finish.

9. Care must be taken in hot-straightening the rails, and it must result in their being left in such a condition that they shall not vary throughout their entire length more than 5 ins. from a straight line in any direction when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so stamped. The distance between supports of rails in the gagging press shall not be less than 42 ins. Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variations to be not more than $\frac{1}{32}$ in., and, prior to shipment, shall have the burr occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Branding.

10. The name of the maker, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat and the letters O. H. (to designate the grade of steel) shall be so stamped on each

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rail as not to be covered by the splice bars. For rails weighing 70 lbs. per yard or over, a letter shall be stamped on the side of the web to indicate the portion of the ingot from which the rail was rolled.

No. 2 Rails 11. No. 2 rails will be accepted to at least 5 per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

Inspection. 12. The manufacturer shall furnish the inspector a chemical analysis of each heat of steel covering the elements specified. Analyses shall be made on drillings taken from small test ingots, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of said test ingots. On request of the inspector the manufacturer shall furnish drillings for check analysis.

The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the rails are being made in accordance with the terms of the contract. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR STEEL SPLICE BARS.

ADOPTED AUGUST 16, 1909.

Process of Manufacture.

1. Steel for splice bars may be made by the Bessemer or open-hearth process.

Phosphorus Limit.

2. The phosphorus in steel for splice bars shall not exceed 0.10 per cent.

Tensile Tests.

3. Splice bar steel shall conform to the following physical qualities:

Tensile strength, pounds per square inch...	54,000 to 64,000
Yield point, pounds per square inch.....	½ T. S.
Elongation, per cent. in eight inches shall not be less than.....	25

Bending Tests.

4. (*a*) A test specimen cut from the head of the splice bar shall bend 180° flat on itself without fracture on the outside of the bent portion.

(*b*) If preferred the bending tests may be made on an unpunched splice bar, which, if necessary, shall be first flattened, and shall then be bent 180° flat on itself without fracture on the outside of the bent portion.

Test Specimen for Tensile Test.

5. A test specimen of 8-inch gauged length, cut from the rolled splice bar, shall be used to determine the physical properties specified in Paragraph 3.

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Number of Tensile Tests. 6. One tensile test specimen shall be taken from the rolled splice bars of each blow or melt, but in case this develops flaws, or breaks outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor.

Test Specimen for Bending. 7. One test specimen cut from the head of the splice bar shall be taken from a rolled bar of each blow or melt, or if preferred the bending test may be made on an unpunched splice bar, which, if necessary, shall be flattened before testing. The bending test may be made by pressure or by blows.

Yield Point. 8. For the purposes of these specifications, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

Sample for Chemical Analysis. 9. In order to determine if the material conforms to the chemical limitations prescribed in Paragraph 2 herein, analysis shall be made of drillings taken from a small test ingot.

Finish. 10. All splice bars shall be smoothly rolled and true to templet. The bars shall be sheared accurately to length and free from fins or cracks, and shall perfectly fit the rails for which they are intended. The punching and notching shall accurately conform in every respect to the drawing and dimensions furnished.

Branding. 11. The name of the maker and the year of manufacture shall be rolled in raised letters on the side of the splice bar.

Inspection. 12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR BRIDGES.

ADOPTED AUGUST 16, 1909.

1. Steel shall be made by the open-hearth process. **Manufacture.**

2. The chemical and physical properties shall conform to the following limits: **Chemical Composition.**

Properties Considered.	Structural Steel.	Rivet Steel.	Steel Castings
Phosphorus, Max. { Basic	0.04 per cent.	0.04 per cent.	0.05 per cent.
Phosphorus, Max. { Acid	0.06 "	0.04 "	0.08 "
Sulphur, Max.	0.05 "	0.04 "	0.05 "
Ult. tensile strength .. Pounds per sq. in...	Desired. 60,000	Desired 50,000	Not less than 65,000
Elong.: Min. per cent. in 8 in. (Fig. 1)	$\frac{1,500,000*}{\text{Ult. tens. str.}}$	$\frac{1,500,000}{\text{Ult. tens. str.}}$	
Elong.: Min. per cent. in 2 in. (Fig. 2)	22	.....	18
Character of fracture .	Silky	Silky	Silky or fine granular.
Cold bend without fracture	180 degrees flat†	180 degrees flat‡	90 degrees. d = 3t

* See par. 11. † See par. 12, 13 and 14. ‡ See par. 15.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

3. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest may be made, at the discretion of the inspector, on the same gauge, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate. **Retests.**

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Chemical Determination.

4. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be allowed.

Plates, Shapes and Bars.

5. Specimens for tensile and bending tests for plates, shapes and bars shall be made by cutting coupons from the finished pro-

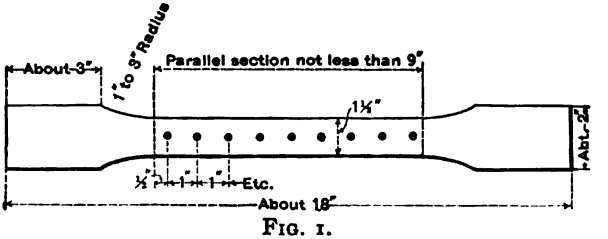


FIG. 1.

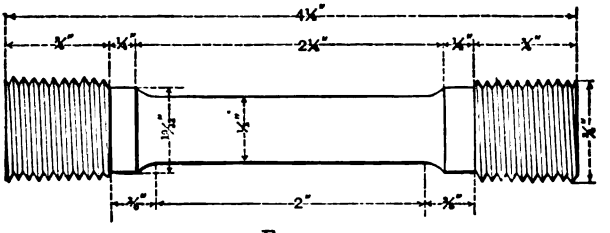


FIG. 2.

duct, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾ inch for a length of at least 9 inches, with enlarged ends.

Rivets.

6. Rivet rods shall be tested as rolled.

Pins and Rollers.

7. Specimens shall be cut from the finished rolled or forged bar in such manner that the center of the specimen shall be 1 inch from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be 1 inch by ½ inch in section.

Steel Castings.

8. The number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from

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coupons molded and cast on some portion of one or more castings from each melt or from the sink-heads, if the heads are of sufficient size. The coupon or sink-head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

Conditions for Tests.

9. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimens for tensile tests representing such material shall be cut from properly annealed or similarly treated short lengths of the full section of the bar.

Number of Tests.

10. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing $\frac{3}{8}$ inch and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Elongation.

11. For material less than $\frac{5}{16}$ inch and more than $\frac{3}{4}$ inch in thickness the following modifications will be allowed in the requirements for elongation:

(*a*) For each $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch, a deduction of $2\frac{1}{2}$ will be allowed from the specified percentage.

(*b*) For each $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch, a deduction of 1 will be allowed from the specified percentage.

Bending Tests.

12. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than 1 inch thick shall bend as called for in Paragraph 2.

Full-sized Bends.

13. Full-sized material for eye-bars and other steel 1 inch thick and over, tested as rolled, shall bend cold 180° around a pin the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Tests for Angles.

14. Angles $\frac{3}{4}$ inch and less in thickness shall open flat, and angles $\frac{1}{2}$ inch and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test will be made only when required by the inspector.

Tests on Rivet Steel.

15. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine, silky, uniform fracture.

Finish.

16. Finished material shall be free from injurious seams, flaws, cracks, defective edges, or other defects, and have a smooth

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uniform, workmanlike finish. Plates 36 inches in width and under shall have rolled edges.

Marking. 17. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it. Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Rejections. 18. Material which, subsequent to the above tests at the mills and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Permissible Variations. 19. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates.

WHEN ORDERED TO WEIGHT.

Plates 12½ pounds per square foot or heavier:

(*c*) Up to 100 inches wide, 2½ per cent. above or below the prescribed weight.

(*d*) 100 inches wide and over, 5 per cent. above or below.

Plates under 12½ pounds per square foot:

(*e*) Up to 75 inches wide, 2½ per cent. above or below.

(*f*) 75 inches and up to 100 inches wide, 5 per cent. above or 3 per cent. below.

(*g*) 100 inches wide and over, 10 per cent. above or 3 per cent. below.

WHEN ORDERED TO GAUGE.

Plates will be accepted if they measure not more than 0.01 inch below the ordered thickness.

An excess over the nominal weight corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following tables, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

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Plates ¼ inch and over in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs.	Width of Plate.			
		Up to 75 in.	75 in. and up to 100 in.	100 in. and up to 115 in.	Over 115 in.
1-4	10.20	10 per cent.	14 per cent.	18 per cent.	.....
5-16	12.75	8 " "	12 " "	16 " "	.....
5-8	15.30	7 " "	10 " "	13 " "	17 per cent.
7-16	17.85	6 " "	8 " "	10 " "	13 " "
1-2	20.40	5 " "	7 " "	9 " "	12 " "
9-16	22.95	4½ " "	6½ " "	8½ " "	11 " "
5-8	25.50	4 " "	6 " "	8 " "	10 " "
Over 5-8	.....	3½ " "	5 " "	6½ " "	9 " "

Plates under ¼ inch in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.		
		Up to 50. in.	50 in. and up to 70 in.	Over 70 in.
1-8 up to 5-32	5.10 to 6.37	10 per cent.	15 per cent.	20 per cent.
5-32 " 3-16	6.37 " 7.65	8½ " "	12½ " "	17 " "
3-16 " 1-4	7.65 " 10.20	7 " "	10 " "	15 " "

Inspection and Testing.

20. The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled, nor work done, before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection.

21. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

22. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR BUILDINGS.

ADOPTED AUGUST 16, 1909.

Manufacture. 1. Structural steel may be made by either the open-hearth or Bessemer process.

Rivet steel and plate or angle material over $\frac{3}{4}$ inch thick, which is to be punched, shall be made by the open-hearth process.

Chemical and Physical Properties. 2. The chemical and physical properties shall conform to the following limits:

Properties Considered.	Structural Steel.	Rivet Steel, Open Hearth.
Phosphorus, max., Bessemer	0.10 per cent.	
Phosphorus, max., open hearth	0.06 "	0.06 per cent.
Ult. tensile strength, pounds per sq. in	55,000–65,000	48,000–58,000
Yield point	$\frac{1}{2}$ Ult. tens. str.	$\frac{1}{2}$ Ult. tens. str.
Elongation, min. per cent. in 8 ins., (Fig. 1)	$\frac{1,400,000*}{\text{Ult. tens. str.}}$	$\frac{1,400,000}{\text{Ult. tens. str.}}$
Character of fracture	Silky	Silky
Cold bend without fracture	180° to diameter of 1 thickness	180° flat

* See paragraph 7.

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For the purposes of these specifications, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

3. In order to determine if the material conforms to the chemical limitations prescribed in Paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt or blow of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. **Chemical Determinations.**

4. Specimens for tensile and bending tests shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾ inch for a length of at least 9 inches, with enlarged ends. **Form of Specimens.**

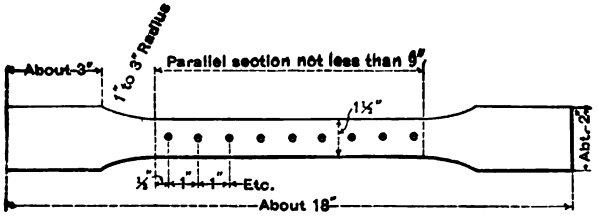


FIG. 1.

(*a*) For material more than ¾ inch thick the bending test specimen may be 1 inch by ½ inch in section.

(*b*) Rivet rounds and small rolled bars shall be tested as rolled.

5. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimens for tensile tests, representing such material, shall be cut from properly annealed or similarly treated short lengths of the full section of the bar. **Annealed Specimens.**

6. At least one tensile and one bending test shall be made from each melt or blow of steel as rolled. In case steel differing ⅜ inch and more in thickness is rolled from one melt or blow, a test shall be made from the thickest and thinnest material rolled. Should either of these test specimens develop flaws, or should the tensile test specimen break outside of the middle third of its gauged length, it may be discarded and another test specimen **Number of Tests.**

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substituted therefor. In case a tensile test specimen does not meet the specification, additional tests may be made.

(*c*) The bending test may be made by pressure or by blows.

Modifications in Elongation for Thin and Thick Material.

7. For material less than $\frac{5}{16}$ inch and more than $\frac{3}{4}$ inch in thickness, the following modifications shall be made in the requirements for elongation:

(*d*) For each increase of $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch, a deduction of 1 shall be made from the specified percentage of elongation.

(*e*) For each decrease of $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch, a deduction of $2\frac{1}{2}$ shall be made from the specified percentage of elongation.

(*f*) For pins, the required percentage of elongation shall be 5 less than that specified in Paragraph 2, as determined on a test specimen, the center of which shall be 1 inch from the surface.

Finish.

8. Finished material must be free from injurious seams, flaws, or cracks, and have a workmanlike finish.

Branding.

9. Test specimens and every finished piece of steel shall be stamped with melt or blow number, except that small pieces may be shipped in bundles securely wired together, with the melt or blow number on a metal tag attached.

Variation in Weight.

10. A variation in cross-section or weight of each piece of steel of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates.

WHEN ORDERED TO WEIGHT.

Plates $12\frac{1}{2}$ *pounds per square foot or heavier:*

(*g*) Up to 100 inches wide, $2\frac{1}{2}$ per cent. above or below the prescribed weight.

(*h*) 100 inches wide and over, 5 per cent. above or below.

Plates under $12\frac{1}{2}$ *pounds per square foot:*

(*i*) Up to 75 inches wide, $2\frac{1}{2}$ per cent. above or below. 75 inches and up to 100 inches wide, 5 per cent. above or 3 per cent. below.

(*j*) 100 inches wide and over, 10 per cent. above or 3 per cent. below.

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WHEN ORDERED TO GAUGE.

Plates will be accepted if they measure not more than 0.01 inch below the ordered thickness.

An excess over the nominal weight corresponding to the dimensions on the order will be allowed for each plate, if not more than that shown in the following tables, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

Plates ¼ inch and over in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.			
		Up to 75 ins.	75 ins. and up to 100 ins.	100 ins. and up to 115 ins.	Over 115 ins.
1–4	10.20	10 per cent.	14 per cent.	18 per cent.	
5–16	12.75	8 "	12 "	16 "	
3–8	15.30	7 "	10 "	13 "	17 per cent.
7–16	17.85	6 "	8 "	10 "	13 "
1–2	20.40	5 "	7 "	9 "	12 "
9–16	22.95	4½ "	6½ "	8½ "	11 "
5–8	25.50	4 "	6 "	8 "	10 "
Over 5–8	.....	3½ "	5 "	6½ "	9 "

Plates under ¼ inch in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.		
		Up to 50 ins.	50 ins. and up to 70 ins.	Over 70 ins.
1–8 up to 5–32	5.10 to 6.37	10 per cent.	15 per cent.	20 per cent.
5–32 " 3–16	6.37 to 7.65	8½ "	12½ "	17 "
3–16 " 1–4	7.65 to 10.20	7 "	10 "	15 "

Inspection.

11. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications.

All tests and inspections shall be made at the place of manufacture, prior to shipment.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR SHIPS.

ADOPTED AUGUST 16, 1909.

Manufacture. 1. Steel shall be made by the open-hearth process.

Chemical and Physical Properties. 2. The chemical and physical properties shall conform to the following limits:

Properties Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, max. { Basic / Acid	0.04 per cent. / 0.06 "	0.04 per cent. / 0.06 "	0.05 per cent. / 0.08 "
Sulphur, max.	.....	0.05 "	.....
Ult. tensile strength, pounds per sq. in.	55,000–65,000	48,000 -58,000	60,000 minimum
Yield point	½ Ult. tens. str.	½ Ult. tens. str.	½ Ult. tens. str.
Elong., min. per cent. in 8 in. (Fig. 1)	1,500,000 / Ult. tens. str.	1,500,000 / Ult. tens. str.	.....
Elong., min. per cent. in 2 in. (Fig. 2)	.....	.....	18
Character of fracture	Silky	Silky	Silky or fine granular.
Cold bend without fracture	180° flat	180° flat	90° / d = 3t.

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For the purposes of these specifications, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine. **Yield Point.**

3. In order to determine if the material conforms to the chemical limitations prescribed in Paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. A check analysis may be made by the purchaser or his representative if desired, in which case an excess of 25 per cent. above the required limits will be allowed. **Chemical Determinations.**

4. Specimens for tensile and bending tests for structural and rivet steel shall be made by cutting coupons from the finished **Form of Specimens.**

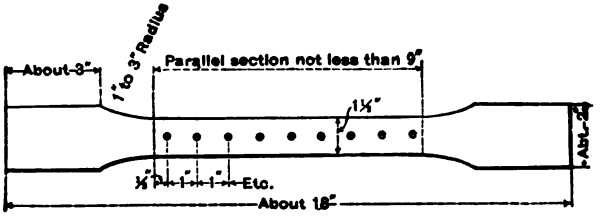


FIG. 1.

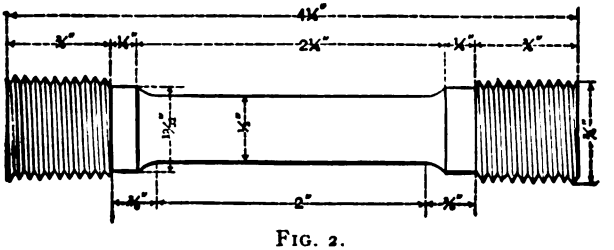


FIG. 2.

product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾ inch for a length of at least 9 inches, with enlarged ends.

(*a*) Rivet rounds and small rolled bars shall be tested as rolled.

5. The number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from **Steel Castings.**

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coupons molded and cast on some portion of one or more castings from each melt or from the sink-heads, if the heads are of sufficient size. The coupon or sink-head so used shall be annealed with the casting before it is cut off. Test specimens shall be of the form shown by Fig. 2.

Annealed Specimens.

6. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimens for tensile tests, representing such material, shall be cut from properly annealed or similarly treated short lengths of the full section of the bar.

Number of Tests.

7. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing $\frac{3}{8}$ inch and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled. Should either of these test specimens develop flaws, or should the tensile test specimen break outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor. In case a tensile test specimen does not meet the specifications, additional tests may be made.

Modifications in Elongation for Thin and Thick Material.

8. For material less than $\frac{5}{16}$ inch and more than $\frac{3}{4}$ inch in thickness, the following modifications will be allowed in the requirements for elongation:

(*b*) For each $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch, a deduction of $2\frac{1}{2}$ will be allowed from the specified percentage.

(*c*) For each $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch, a deduction of 1 will be allowed from the specified percentage.

Bending Tests.

9. Plates, shapes and bars less than $\frac{3}{4}$ inch thick shall bend as called for in Paragraph 2.

(*d*) Steel $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches thick, inclusive, tested as rolled, shall bend cold 180° around a pin the diameter of which is equal to one and one-half times the thickness of the bar, without fracture on the outside of bend.

(*e*) Steel over $1\frac{1}{4}$ inches thick, tested as rolled, shall bend cold 180° around a pin the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

(*f*) Bending tests may be made by pressure or by blows.

Tests on Angles.

10. Angles $\frac{3}{4}$ inch and less in thickness shall open flat, and angles $\frac{1}{2}$ inch and less in thickness shall bend shut, cold, under

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blows of a hammer, without sign of fracture. This test will be made only when required by the inspector.

Finish. 11. Finished material shall be free from injurious seams, flaws, cracks, defective edges, or other defects, and shall have a smooth, uniform, workmanlike finish.

Marking. 12. Test specimens and every finished piece of steel shall be stamped with the melt number, except that small pieces may be shipped in bundles securely wired together, with the melt number on a metal tag attached.

Variation in Weight. 13. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates.

WHEN ORDERED TO WEIGHT.

Plates 12½ pounds per square foot or heavier:

(*g*) Up to 100 inches wide, 2½ per cent. above or below the prescribed weight.

(*h*) 100 inches wide and over, 5 per cent. above or below.

Plates under 12½ pounds per square foot:

(*i*) Up to 75 inches wide, 2½ per cent. above or below.
75 inches and up to 100 inches wide, 5 per cent. above or 3 per cent. below.

(*j*) 100 inches wide and over, 10 per cent. above or 3 per cent. below.

WHEN ORDERED TO GAUGE.

Plates will be accepted if they measure not more than 0.01 inch below the ordered thickness.

An excess over the nominal weight corresponding to the dimensions on the order will be allowed for each plate, if not more than that shown in the following tables, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

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Plates ¼ inch and over in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.			
		Up to 75 ins.	75 ins. and up to 100 ins.	100 ins. and up to 115 ins.	Over 115 ins.
1-4	10.20	10 per cent.	14 per cent.	18 per cent.	
5-16	12.75	8 "	12 "	16 "	
3-8	15.30	7 "	10 "	13 "	17 per cent.
7-16	17.85	6 "	8 "	10 "	13 "
1-2	20.40	5 "	7 "	9 "	12 "
9-16	22.95	4½ "	6½ "	8½ "	11 "
5-8	25.50	4 "	6 "	8 "	10 "
Over 5-8	.....	3½ "	5 "	6½ "	9 "

Plates under ¼ inch in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.		
		Up to 50 ins.	50 ins. and up to 70 ins.	Over 70 ins.
1-8 up to 5-32	5.10 to 6.37	10 per cent.	15 per cent.	20 per cent.
5-32 " 3-16	6.37 to 7.65	8½ "	12½ "	17 "
3-16 " 1-4	7.65 to 10.20	7 "	10 "	15 "

Inspection. 14. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications.

The manufacturer shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

All tests and inspections shall be made at the place of manufacture, prior to shipment.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STEEL AXLES.

ADOPTED SEPTEMBER 1, 1905.

1. Steel for axles shall be made by the open-hearth process. **Manufacture.**

2. There will be three classes of steel axles which shall conform to the following limits in chemical composition. **Chemical Properties.**

	Car and Tender Truck Axles. Per cent.	Driving and Engine Truck Axles. (Carbon Steel.) Per cent.	Driving and Engine Truck Axles. (Nickel Steel.) Per cent.
Phosphorus shall not exceed	0.06	0.06	0.04
Sulphur " " "	0.06	0.06	0.04
Manganese " " "	....	0.60	....
Nickel	....	....	3.0 to 4.0

3. For car and tender truck axles no tensile test shall be required. **Physical Properties.**

4. The minimum physical qualities required in the two classes of driving and engine truck axles shall be as follows:

	Driving and Engine Truck Axles. (Carbon Steel.)	Driving and Engine Truck Axles. (Nickel Steel.)
Tensile strength, pounds per square inch..	80,000	80,000
Yield point, pounds per square inch	40,000	50,000
Elongation, per cent. in two inches	20	25
Contraction of area, per cent.	25	45

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Drop Test.

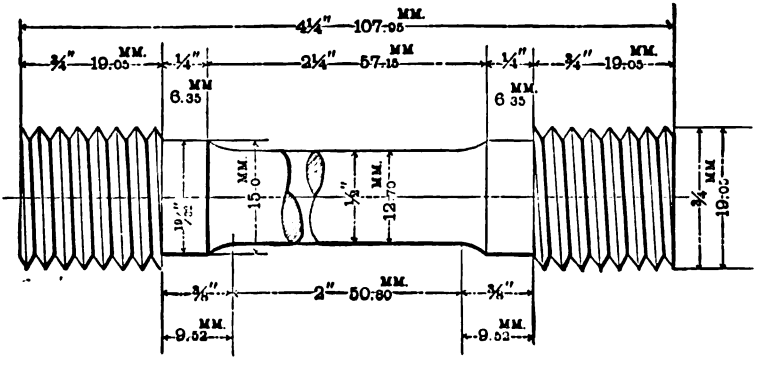
5. One axle selected from each melt, when tested by the drop test described in Paragraph 9, shall stand the number of blows at the height specified in the following table without rupture and without exceeding, as the result of the first blow, the deflection given. Any melt failing to meet these requirements will be rejected.

Diameter of Axle at Center. Inches.	Number of Blows.	Height of Drop. Feet.	Deflection. Inches.
4 1/2	5	24	8 1/4
4 5/8	5	26	8 1/4
4 3/4	5	28 1/2	8 1/4
4 7/8	5	31	8
4	5	34	8
5	5	43	7
5 1/8	7	43	5 1/2

6. Carbon steel and nickel steel driving and engine truck axles shall not be subject to the above drop test.

Test Pieces and Methods of Testing.

7. The standard test specimen one-half (1/2) inch diameter and two (2) inches gauged length, shall be used to determine the physical properties specified in Paragraph 4. It is shown in the following sketch:



Number and Location of Tensile Specimens.

8. For driving and engine truck axles one longitudinal test specimen shall be cut from one axle of each melt. The center of this test specimen shall be half-way between the center and outside of the axle.

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9. The points of supports on which the axle rests during tests must be three feet apart from center to center; the tup must weigh 1,640 pounds; the anvil, which is supported on springs, must weigh 17,500 pounds; it must be free to move in a vertical direction; the springs upon which it rests must be twelve in number, and the radius of supports and of the striking face on the tup in the direction of the axis of the axle must be five (5) inches. When an axle is tested it must be so placed in the machine that the tup will strike it midway between the ends, and it must be turned over after the first and third blows, and when required, after the fifth blow. To measure the deflection after the first blow prepare a straight edge as long as the axle, by reinforcing it on one side, equally at each end, so that when it is laid on the axle, the reinforced parts will rest on the collars or ends of the axle, and the balance of the straight edge not touch the axle at any place. Next place the axle in position for test, lay the straight edge on it, and measure the distance from the straight edge to the axle at the middle point of the latter. Then after the first blow, place the straight edge on the now bent axle in the same manner as before, and measure the distance from it to that side of the axle next to the straight edge at the point farthest away from the latter. The difference between the two measurements is the deflection. The report of the drop test shall state the atmospheric temperature at the time the tests were made. **Drop Test Described.**

10. The yield point specified in Paragraph 4 shall be determined by the careful observation of the drop of the beam, or halt in the gauge of the testing machine. **Yield Point.**

11. Turnings from the tensile test specimen of driving and engine truck axles, or drillings taken midway between the center and outside of car, and tender truck axles, or drillings from the small test ingot, if preferred by the inspector, shall be used to determine whether the melt is within the limits of chemical composition specified in Paragraph 2. **Sample for Chemical Analysis.**

12. Axles shall conform in sizes, shapes and limiting weights to the requirements given on the order or print sent with it. They shall be made and finished in a workmanlike manner, and shall be free from all injurious cracks, seams or flaws. In centering, sixty (60) degree centers must be used, with clearance given at the point to avoid dulling the shop lathe centers. **Finish.**

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Branding. 13. Each axle shall be legibly stamped with the melt number and initials of the maker at the places marked on the print or indicated by the inspector.

Inspection. 14. The inspector representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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STANDARD SPECIFICATIONS FOR HEAT-TREATED CARBON-STEEL AXLES, SHAFTS, AND SIMILAR PARTS.

ADOPTED AUGUST 21, 1911.

Process of Manufacture.

1. Steel under this specification shall be made by the open-hearth or other approved process.

Discard.

2. A sufficient amount of discard must be made from each ingot to insure freedom from piping and undue segregation.

Chemical Composition.

3. The steel shall conform to the following limits in chemical composition:

Carbon	Not over 0.60 per cent.
Manganese	0.40 to 0.80 " "
Phosphorus	Not over 0.05 " "
Sulphur	" " 0.05 " "

Samples for Chemical Analysis.

4. Drillings shall be taken from the crop end of one axle, shaft, or similar part from each melt represented, parallel to the axis on any radius one-half the distance from the center to circumference, to determine whether the chemical composition of the heat is within the limits specified in Paragraph 3.

In addition to the complete analysis, the purchaser has a right to call for a phosphorus determination, to be made from turnings from each tensile test specimen, and the phosphorus must show within the limits called for by Paragraph 3.

Tensile Test.

5. The steel shall conform to the following minimum physical properties:

Ultimate strength, lbs. per sq. in.	85,000
Elastic limit, " "	50,000
Elongation in 2 ins., per cent.	22
Reduction of area, "	45

The elastic limit shall be determined by extensometer. Above

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40,000 lbs. per sq. in., each increment of load shall be not more than 1,000 lbs. per sq. in.

cimen for sile Test.

6. The test specimen as shown by Fig. 1, 0.5-in. diameter and 2-in. gauge length, shall be used to determine the physical properties as specified in Paragraph 5. Tests specimens shall be taken from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. A full-size prolongation shall be left on each axle, shaft, or similar part.

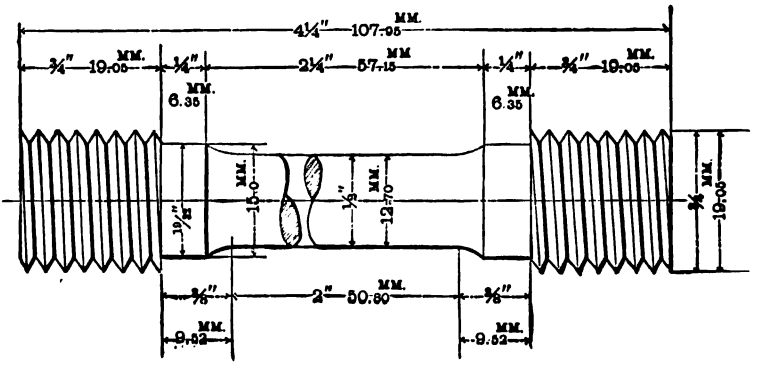


FIG. 1.

i Bend Test.

7. A cold bend test shall be made from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. The test shall be made with a ½-in. square specimen, not exceeding 6 ins. in length, around a flat mandrel with edges of ½-in. radius, and the specimen shall bend, without fracture, 180° around the said mandrel.

ation of cimens for sile Test and i Bend Test.

8. Specimens for tensile test and cold bend test shall be taken parallel to the axis of the axle or shaft and on any radius one-half the distance from the center to the circumference.

testing.

9. In case the physical results obtained from any lot of axles, shafts, or similar parts, do not conform to those called for by Paragraphs 5 and 7, the manufacturer shall have the privilege of re-treating such parts, from which new tests shall be taken by the

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purchaser, and these shall govern the acceptance or rejection of the lot.

Heat Treatment. 10. Each axle, shaft, or similar part shall be allowed to cool after forging, shall then be re-heated to the proper temperature, quenched in some medium, allowed to cool, and then re-heated to the proper temperature for annealing.

Warped Axles or Shafts. 11. Warped axles or shafts or similar parts must be straightened hot; that is, at a temperature above 900° F., and before offering the parts for test.

Quality. 12. All axles, shafts, and similar parts shall be free from cracks, flaws, seams, or other injurious imperfections when finished. Those which show such defects while being finished by the purchaser will be rejected and returned to the manufacturer, who must pay return freight.

Finish. 13. All axles, shafts, and similar parts must be rough-turned with an allowance of $\frac{1}{8}$ in. on surface for finishing, except on collar, which is to be left rough forged. Turning must be done on 60° centers with clearance drilled at point.

Branding. 14. The heat number shall be stamped on the rough forged collar. After rough turning, the manufacturer's name, heat number, individual axle or shaft number, and inspector's mark shall be stamped at place indicated by the purchaser, except at any point between the rough collars.

Inspection. 15. The inspector representing the purchaser shall have free entry, at all times while his contract is being executed, to all portions of the manufacturer's shop which concerns the manufacture of material ordered. All reasonable facilities shall be afforded to the inspector by the manufacturer to satisfy him that the axles, shafts, and similar parts are being furnished in accordance with the specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and free of cost to the purchaser. The purchaser shall have the right to make tests to govern the acceptance or rejection in their own test-room, or elsewhere, as may be decided by the purchaser, such test, however, to be made at the expense of the purchaser and to be made prior to the shipment of the material. Unless otherwise arranged, any protest based on such tests must be made within six days, to be valid. Tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the mill.

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PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR STEEL TIRES.

ADOPTED AUGUST 16, 1909.

Material. 1. Steel for tires shall be made by the open-hearth process.

Classes. 2. There will be three classes of tires for the different classes of service as follows:

(*a*) Driving tires for passenger engines.

(*b*) Driving tires for freight engines and tires for engine-truck, tender-truck, trailer and car wheels.

(*c*) Driving tires for switching engines.

Chemical Composition. 3. The steel for the three classes of service shall conform to the following limits in chemical composition:

Manganese shall not exceed	0.75	per cent.
Silicon shall not exceed	0.35	" "
Phosphorus shall not exceed	0.05	" "
Sulphur shall not exceed	0.05	" "

Samples for Chemical Analyses. 4. Drillings from a small test ingot cast with the heat or turnings from a tensile specimen or turnings from a tire (where tires are machined at the works of the manufacturer) shall be used to determine whether the chemical composition of the heat is within the limits specified in Paragraph 3.

When samples for chemical analyses are taken from the finished material, a variation of 25 per cent. excess in phosphorus and sulphur over the limits specified in Paragraph 3 will be allowed.

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5. When required, the purchaser or his representative shall be furnished an analysis of each heat from which tires are made. **Analyses Furnished.**

6. The steel for the different classes of service shall meet the following minimum physical requirements: **Physical Properties.**

Class.	Tensile strength, lbs. per sq. in.	Elongation, per cent. in 2 ins.	Reduction of area, per cent.
(*a*)	105,000	12	16
(*b*)	115,000	10	14
(*c*)	125,000	8	12

7. Samples for physical tests shall be taken from a test bar from an ingot of each heat represented, the ingot to be of such size as to give as nearly as practicable the same amount of work on the test bar as on the tire. **Samples for Physical Tests.**

8. The standard turned test specimen, as shown by Fig. 1, ½ in. in diameter and 2 ins. gauge length, shall be used to determine the physical properties as specified in Paragraph 6. **Specimen for Tensile Tests.**

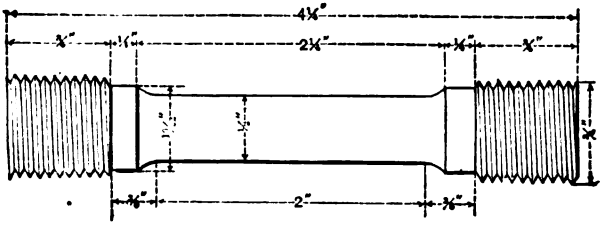


FIG. 1.

9. Should the contract call for a falling-weight test, a test tire from each heat represented shall be selected by the purchaser or his representative, and furnished at his expense provided it meets the requirements. **Falling-weight Test.**

9a. The test tire shall be placed vertically under the drop in a running position on a solid foundation with an anvil of at least ten tons weight and shall be subjected to successive blows from a tup weighing 2,240 lbs., falling from heights of 10 ft., 15 ft. and 20 ft. and upwards, until the required deflection is obtained as specified in Paragraph 9b.

9b. The test tire shall stand the drop test described in Paragraph 9a. without breaking or cracking and shall show a minimum deflection equal to $D^2 \div (40T^2 + 2D)$, D being the

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internal diameter in inches and T the thickness of the tire at center of tread.

9c. When requested, a specimen for the tensile test is to be taken from a tire that has been subjected to a falling-weight test, and it shall be cut cold from the tested tire at the point least affected by the falling-weight test. The tensile test specimen, when cut from a tire that has been subjected to a falling-weight test, shall be cut normal to the radius and parallel to the face.

9d. Should the test tire fail to meet the requirements in any particular, two more test tires shall be selected from the same heat if the manufacturer so desires, and at his expense. Should these two tires fulfill the requirements, the heat shall be accepted.

Finish 10. Tires must be free from cracks, flaws, seams, or other injurious imperfections. Tires developing such defects while being finished shall be returned to the manufacturer at his expense and replaced free of charge.

Tires (when furnished in the rough) shall conform to drawings with the following tolerances:

(*a*) *Height of Flange.*—The height of flange shall not be more than $\frac{3}{32}$ in. over or under the height called for.

(*b*) *Width of Flange.*—The width of flange shall not be more than $\frac{1}{16}$ in. over or under the dimensions called for.

(*c*) *Throat Radius.*—The throat radius shall not be more than $\frac{1}{8}$ in. greater nor more than $\frac{1}{16}$ in. less than the radius called for.

(*d*) *Width of Tire.*—The width of tire shall not be more than $\frac{1}{8}$ in. greater nor more than $\frac{1}{16}$ in. less than the width called for.

(*e*) *Inside Diameter.*—The diameter shall not be less than the diameter of the finished tire by more than $\frac{3}{8}$ in.

(*f*) *Outside Diameter.*—Tires 33 ins. or less in inside diameter shall be furnished in sets not varying more than $\frac{1}{16}$ in. in outside diameters and not out of round more than $\frac{1}{16}$ in.

Tires over 33 ins. in inside diameter shall be furnished in sets not varying more than $\frac{3}{32}$ in. in outside diameter and not out of round more than $\frac{3}{32}$ in.

Branding. 11. The manufacturer's brand and serial number shall be

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stamped on the tire close to the inside edge where the stamping will not be cut off at the last turning. Set numbers shall be stenciled on each tire.

12. The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed. All reasonable facilities shall be afforded to the inspector by the manufacturer to satisfy him that the tires are being furnished in accordance with the specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and shall be so conducted as not to interfere unnecessarily with the operation of the mill. Inspection.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STEEL FORGINGS.

ADOPTED SEPTEMBER 1, 1905.

Manufacture. 1. Steel for forgings may be made by the open-hearth, crucible or Bessemer process.

Chemical Properties. 2. There will be four classes of steel forgings which shall conform to the following limits in chemical composition.

	Forgings of Soft or Low Carbon Steel. Per cent.	Forgings of Carbon Steel not Annealed. Per cent.	Forgings of Carbon Steel, Oil Tempered or Annealed. Per cent.	Locomotive Forgings. Per cent.	Forgings of Nickel Steel, Oil Tempered or Annealed. Per cent.
Phosphorus shall not exceed	0.10	0.06	0.04	0.05	0.04
Sulphur " " "	0.10	0.06	0.04	0.05	0.04
Manganese " " "	....	....	....	0.60	....
Nickel	....	....	....	....	3.0 to 4.0

Physical Properties. 3. The minimum physical qualities required of the different sized forgings of each class shall be as follows:

	Tensile Strength. Pounds per square inch.	Yield Point. Pounds per square inch.	Elongation in 2 in. Per cent.	Contraction of Area. Per cent.
SOFT STEEL OR LOW CARBON STEEL.				
For solid or hollow forgings, no diameter or thickness of section to exceed 10 in.	58,000	29,000	28	35
CARBON STEEL NOT ANNEALED.				
For solid or hollow forgings, no diameter or thickness of section to exceed 10 in.	75,000	37,500	18	30

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	Tensile Strength.	Elastic Limit.	Elongation in 2 in.	Contraction of Area.
	Pounds per square inch.		Per cent.	
CARBON STEEL ANNEALED.				
For solid or hollow forgings, no diameter or thickness of section to exceed 10 in.	80,000	40,000	22	35
For solid forgings, no diameter to exceed 20 in. or thickness of section 15 in.	75,000	37,500	23	35
For solid forgings, over 20 in. diameter	70,000	35,000	24	30
CARBON STEEL, OIL TEMPERED.				
For solid or hollow forgings, no diameter or thickness of section to exceed 3 in.	90,000	55,000	20	45
CARBON STEEL, OIL TEMPERED.				
For solid forgings of rectangular sections not exceeding 6 in. in thickness or hollow forgings, the walls of which do not exceed 6 in. in thickness	85,000	50,000	22	45
For solid forgings of rectangular sections not exceeding 10 in. in thickness or hollow forgings, the walls of which do not exceed 10 in. in thickness	80,000	45,000	23	40
LOCOMOTIVE FORGINGS.	80,000	40,000	20	25
NICKEL STEEL ANNEALED.				
For solid or hollow forgings, no diameter or thickness of section to exceed 10 in.	80,000	50,000	25	45
For solid forgings, no diameter to exceed 20 in. or thickness of section 15 in.	80,000	45,000	25	45
For solid forgings, over 20 in. diameter	80,000	45,000	24	40
NICKEL STEEL, OIL TEMPERED.				
For solid or hollow forgings, no diameter or thickness of section to exceed 3 in.	95,000	65,000	21	50
For solid forgings of rectangular sections not exceeding 6 in. in thickness or hollow forgings, the walls of which do not exceed 6 in. in thickness	90,000	60,000	22	50
For solid forgings of rectangular sections not exceeding 10 in. in thickness or hollow forgings, the walls of which do not exceed 10 in. in thickness	85,000	55,000	24	45

4. A specimen one inch by one-half inch (1 in. x ½ in.) shall bend cold 180° without fracture on outside of bent portion, as follows: Bending Test

Around a diameter of ½ in., for forgings of soft steel,

Around a diameter of 1½ in., for forgings of carbon steel not annealed,

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Around a diameter of 1½ in., for forgings of carbon steel annealed, if 20 in. in diameter or over,

Around a diameter of 1 in., for forgings of carbon steel annealed, if under 20 in. diameter,

Around a diameter of 1 in. for forgings of carbon steel oil-tempered,

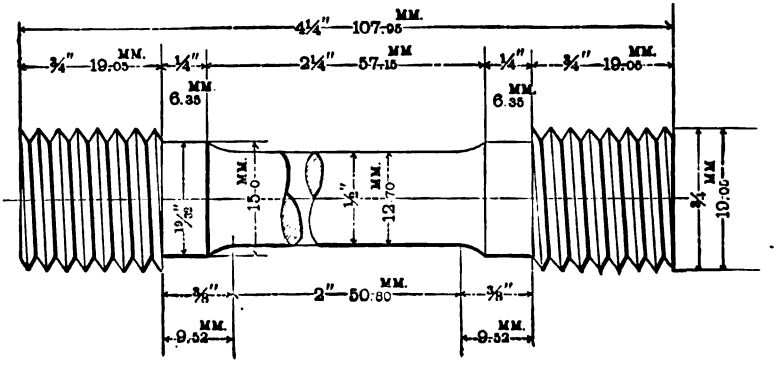
Around a diameter of ½ in., for forgings of nickel steel annealed,

Around a diameter of 1 in., for forgings of nickel steel oil-tempered.

For locomotive forgings no bending test required.

Test Pieces and Methods of Testing.

5. The standard turned test specimen, one-half inch (½ in.) diameter and two inch (2 in.) gauged length, shall be used to deter-



mine the physical properties specified in Paragraph 3. It is shown in the above sketch.

Number and Location of Tensile Specimens.

6. The number and location of test specimens to be taken from a melt, blow, or a forging shall depend upon its character and importance and must therefore be regulated by individual cases. The test specimens shall be cut cold from the forging or full-sized prolongation of same parallel to the axis of the forging and halfway between the center and outside, the specimens to be longitudinal, i. e., the length of the specimen to correspond with the direction in which the metal is most drawn out or worked. When forgings have large ends or collars, the test specimens shall be taken from a prolongation of the same diameter or section as that of the forging back of the large end or collar. In the case of hollow

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shafting, either forged or bored, the specimen shall be taken within the finished section prolonged, half-way between the inner and outer surface of the wall of the forging.

Test Specimen for Bending.

7. The specimen for bending test one inch by one-half inch (1 in. x ½ in.) shall be cut as specified in Paragraph 6. The bending test may be made by pressure or by blows.

Yield Point.

8. The yield point specified in Paragraph 3 shall be determined by the careful observation of the drop of the beam, or halt in the gauge of the testing machine.

Elastic Limit.

9. The elastic limit specified in Paragraph 3 shall be determined by means of an extensometer, which is to be attached to the test specimen in such manner as to show the change in rate of extension under uniform rate of loading, and will be taken at that point where the proportionality changes.

Sample for Chemical Analysis.

10. Turnings from the tensile specimen or drillings from the bending specimen or drillings from the small test ingot, if preferred by the inspector, shall be used to determine whether or not the steel is within the limits in chemical composition specified in Paragraph 2.

Finish.

11. Forging shall be free from cracks, flaws, seams or other injurious imperfections, and shall conform to dimensions shown on drawings furnished by the purchaser, and be made and finished in a workmanlike manner.

Inspection.

12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR STEEL CASTINGS.

ADOPTED SEPTEMBER 1, 1905.

Process of Manufacture.

1. Steel for castings may be made by the open-hearth, crucible or Bessemer process. Castings to be annealed unless otherwise specified.

Chemical Properties.

2. Ordinary castings, those in which no physical requirements are specified, shall not contain over 0.40 per cent. of carbon, nor over 0.08 per cent. of phosphorus.

3. Castings which are subjected to physical test shall not contain over 0.05 per cent. of phosphorus, nor over 0.05 per cent. of sulphur.

Tensile Tests.

4. Tested castings shall be of three classes: "HARD," "MEDIUM," and "SOFT." The minimum physical qualities required in each class shall be as follows:

	Hard castings.	Medium castings.	Soft castings.
Tensile strength, pounds per square inch	85,000	70,000	60,000
Yield point, pounds per square inch....	38,250	31,500	27,000
Elongation, per cent. in two inches....	15	18	22
Contraction of area, per cent.....	20	25	30

Drop Test.

5. A test to destruction may be substituted for the tensile test, in the case of small or unimportant castings, by selecting three castings from a lot. This test shall show the material to be ductile and free from injurious defects, and suitable for the purposes intended. A lot shall consist of all castings from the same melt or blow, annealed in the same furnace charge.

Percussive Test.

6. Large castings are to be suspended and hammered all over.

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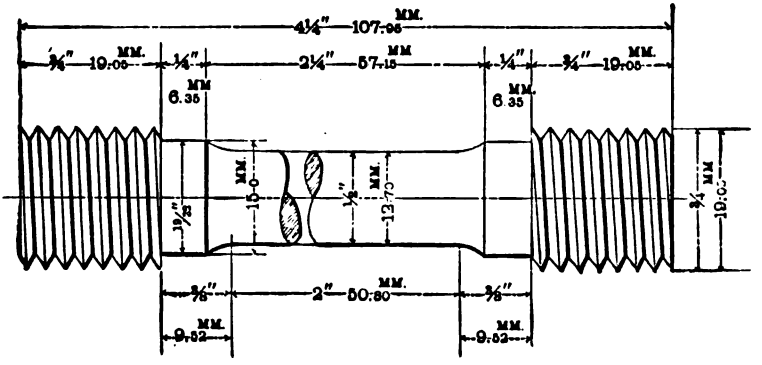
No cracks, flaws, defects, nor weakness shall appear after such treatment.

Bending Test.

7. A specimen one inch by one-half inch (1 in. x ½ in.) shall bend cold around a diameter of one inch (1 in.) without fracture on outside of bent portion, through an angle of 120° for "SOFT" castings, of 90° for "MEDIUM" castings.

Test Piece for Tensile Test.

8. The standard turned test specimen, one-half inch (½ in.) in diameter and two inch (2 in.) gauged length shall be used to determine the physical properties specified in Paragraph 4. It is shown in the following sketch:



Number and Location of Specimens.

9. The number of standard test specimens shall depend upon the character and importance of the castings. A test piece shall be cut cold from a coupon to be molded and cast on some portion of one or more castings from each melt or blow or from the sink-heads (in case heads of sufficient size are used). The coupon or sink-head must receive the same treatment as the casting or castings, before the specimen is cut out, and before the coupon or sink-head is removed from the casting.

Test Piece for Bending.

10. One specimen for bending test one inch by one-half inch (1 in. x ½ in.) shall be cut cold from the coupon or sink-head of the casting or castings as specified in Paragraph 9. The bending test may be made by pressure, or by blows.

Yield Point.

11. The yield point specified in Paragraph 4 shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

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Sample for Chemical Analysis.

12. Turnings from the tensile specimen, drillings from the bending specimen, or drillings from the small test ingot, if preferred by the inspector, shall be used to determine whether or not the steel is within the limits in phosphorus and sulphur specified in Paragraphs 2 and 3.

Finish.

13. Castings shall be true to pattern, free from blemishes, flaws or shrinkage cracks. Bearing surfaces shall be solid, and no porosity shall be allowed in positions where the resistance and value of the casting for the purpose intended, will be seriously affected thereby.

Inspection.

14. The inspector representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR STEEL REINFORCEMENT BARS.

ADOPTED AUGUST 21, 1911.

1. Steel may be made by either the open-hearth or Bessemer process. Bars shall be rolled from billets. **Manufacture.**

2. The chemical and physical properties shall conform to the following limits: **Chemical and Physical Properties.**

Properties Considered.	Structural Steel Grade.		Hard Grade.*		Cold-Twisted Bars.
	Plain Bars.	Deformed Bars.	Plain Bars.	Deformed Bars.	
Phosphorus, max.					
Bessemer.....	0.10	0.10	0.10	0.10	0.10
Open-Hearth.....	0.05	0.05	0.05	0.05	0.05
Ult. tensile strength, pounds per sq. in...	55,000–70,000	55,000–70,000	80,000 min.	80,000 min.	Recorded only
Yield point, min., pounds per sq. in...	33,000	33,000	50,000	50,000	55,000
Elongation, min. per cent. in 8 ins.....	1,400,000 / tens. str.	1,250,000 / tens. str.	1,200,000 / tens. str.	1,000,000 / tens. str.	5 per cent.
Cold bend without fracture:					
Bars under ¾ in. in diameter or thickness.....	180°d.—1t.	180°d.—1t.	180°d.—3t.	180°d.—4t.	180°d.—2t.
Bars ¾ in. in diameter or thickness and over..	180°d.—1t.	180°d.—2t.	90°d.—3t.	90°d.—4t.	180°d.—3t.

* The hard grade will be used only when specified.

3. In order to determine if the material conforms to the chemical limitations prescribed in Paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt or blow of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. **Chemical Determinations.**

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4. Chemical determinations of the percentage of phosphorus, shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel and a correct copy of such analysis shall be furnished to the engineer or his inspector. A check analysis may be made by the purchaser or his representative if desired, in which case an excess of 25 per cent. above the required limits will be allowed.

Yield Point.

5. For the purposes of these specifications, the yield point shall be determined by careful observation of the drop of the beam of the testing machine, or by other equally accurate method.

Form of Specimens.

6. (*a*) Tensile and bending test specimens may be cut from the bars as rolled, but tensile and bending test specimens of deformed bars may be planed or turned for a length of at least 9 ins. if deemed necessary by the manufacturer in order to obtain uniform cross-section.

(*b*) Tensile and bending test specimens of cold-twisted bars shall be cut from the bars after twisting, and shall be tested in full size without further treatment, unless otherwise specified as in (*c*), in which case the conditions therein stipulated shall govern.

(*c*) If it is desired that the testing and acceptance for cold-twisted bars be made upon the hot-rolled bars before being twisted, the hot-rolled bars shall meet the requirements of the structural steel grade for plain bars shown in this specification.

Number of Tests.

7. At least one tensile and one bending test shall be made from each melt of open-hearth steel rolled, and from each blow or lot of ten tons of Bessemer steel rolled. In case bars differing $\frac{3}{8}$ in. and more in diameter or thickness are rolled from one melt or blow, a test shall be made from the thickest and thinnest material rolled. Should either of these test specimens develop flaws, or should the tensile test specimen break outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor. In case a tensile test specimen does not meet the specifications, an additional test may be made.

(*d*) The bending test may be made by pressure or by light blows.

Modifications in Elongation for Thin and Thick Material.

8. For bars less than $\frac{7}{16}$ in. and more than $\frac{3}{4}$ in. nominal diameter or thickness, the following modifications shall be made in the requirements for elongation:

(*e*) For each increase of $\frac{1}{8}$ in. in diameter or thickness above

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$\frac{3}{4}$ in., a deduction of 1 shall be made from the specified percentage of elongation.

(*f*) For each decrease of $\frac{1}{16}$ in. in diameter or thickness below $\frac{7}{16}$ in., a deduction of 1 shall be made from the specified percentage of elongation.

(*g*) The above modifications in elongation shall not apply to cold-twisted bars.

Number of Twists.

9. Cold-twisted bars shall be twisted cold with one complete twist in a length equal to not more than twelve (12) times the thickness of the bar.

Finish.

10. Material shall be free from injurious seams, flaws, or cracks, and have a workmanlike finish.

Variation in Weight.

11. Bars for reinforcement are subject to rejection if the actual weight of any lot varies more than 5 per cent. over or under the theoretical weight of that lot.

Inspection.

12. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR OPEN-HEARTH BOILER PLATE AND RIVET STEEL.

ADOPTED AUGUST 16, 1909.

Process of Manufacture.

1. Steel shall be made by the open-hearth process.

Chemical and Physical Properties.

2. There shall be three classes of open-hearth boiler plate steel; namely, flange steel, fire box steel and extra soft steel, which shall conform to the following limits in chemical and physical properties:

	Flange Steel.	Fire Box Steel.	Extra Soft Steel.
Phosphorus shall not exceed	Acid 0.06 per cent. Basic 0.04 "	Acid 0.04 per cent. Basic 0.03 "	0.04 per cent.
Sulphur shall not exceed	0.05 "	0.04 "	0.04 "
Manganese	0.30 to 0.60 per cent.	0.30 to 0.50 per cent.	0.30 to 0.50 per cent.
Ult. tensile strength, pounds per sq. in.	55,000–65,000	52,000–62,000	45,000–55,000
Yield point, in pounds per sq. in., shall not be less than	½ Ult. tens. str.	½ Ult. tens. str.	½ Ult. tens. str.
Elongation, per cent. in 8 in. shall not be less than	$\frac{1,500,000}{\text{Ult. tens. str.}}$	$\frac{1,500,000}{\text{Ult. tens. str.}}$	$\frac{1,500,000}{\text{Ult. tens. str.}}$ (but need not exceed 30 per cent.)
Cold bend Quench bend	180° flat.	180° flat.	180° flat.

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(*a*) For the purposes of these specifications, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine. **Yield Point.**

3. Steel for boiler rivets shall be of the extra soft class, as specified in Paragraph 2. **Boiler Rivet Steel.**

4. For material less than $\frac{5}{16}$ inch and more than $\frac{3}{4}$ inch in thickness, the following modifications shall be made in the requirements for elongation: **Modifications in Elongation for Thin and Thick Material.**

(*b*) For each increase of $\frac{1}{8}$ inch in thickness above $\frac{3}{4}$ inch, a deduction of 1 shall be made from the specified percentage of elongation.

(*c*) For each decrease of $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch, a deduction of $2\frac{1}{2}$ shall be made from the specified percentage of elongation.

5. In order to determine if the material conforms to the chemical limitations prescribed in Paragraph 2 herein, analysis shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. A check analysis may be made by the purchaser or his representative, from a broken tensile test specimen representing each heat of flange or extra soft steel on an order, and for each plate as rolled of fire box steel, in which cases an excess of 25 per cent. above the required limits in phosphorus and sulphur will be allowed. **Chemical Determinations.**

6. The standard tensile test specimen of 8-inch gauged length shall be used to determine the physical properties specified in Paragraphs 2 and 3. The standard shape of the tensile test specimen for sheared plates shall be as shown in Fig. 1. **Test Specimen for Tensile Test**

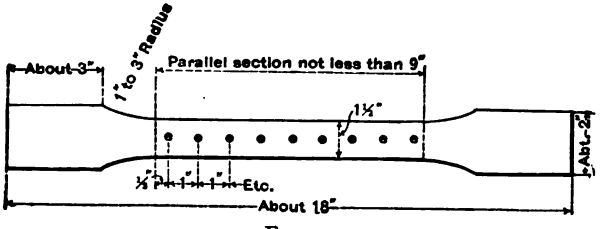


FIG. 1.

For other material the tensile test specimen may be the same as for sheared plates, or it may be planed or turned parallel

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throughout its entire length and in all cases where possible two opposite sides of the test specimens shall be the rolled surfaces.

Rivet rounds and small rolled bars shall be tested of full size as rolled.

Test Specimens for Bending Tests.

7. The bending test specimen shall be 1½ inches wide, if possible, and for all material ¾ inch or less in thickness the test specimen shall have the natural rolled surface on two opposite sides; but for material more than ¾ inch thick, the bending test specimen may be ½ inch thick. The sheared edges of bending test specimens shall be milled or planed. The bending test may be made by pressure or by blows. The cold bending test shall be made on the material in the condition in which it is to be used, and prior to the quenched bending test, the specimen shall be heated to a light cherry red as seen in the dark and quenched in water, the temperature of which is between 80° and 90° Fahrenheit.

Rivet rounds shall be tested of full size as rolled.

Homogeneity Tests.

8. For fire box steel a sample taken from a broken tensile test specimen shall not show any single seam or cavity more than ¼ inch long, in either of the three fractures obtained on the test for homogeneity, as described below:

(*d*) The homogeneity test is made as follows: A portion of the broken tensile test specimen is either nicked with a chisel or grooved on a machine, transversely about $\frac{1}{16}$ inch deep in three places about 2 inches apart. The first groove should be made on one side, 2 inches from the square end of the specimen; the second, 2 inches from it on the opposite side; and the third, 2 inches from the last, and on the opposite side from it. The test specimen is then put in a vise, with the first groove about ¼ inch above the jaws, care being taken to hold it firmly. The projecting end of the test specimen is then broken off by means of a hammer, a number of light blows being used, and the bending being away from the groove. The specimen is broken at the other two grooves in the same way. The object of this treatment is to open and render visible to the eye any seams due to failure to weld up, or to foreign interposed matter, or cavities due to gas bubbles in the ingot. After rupture, one side of each fracture is examined, a pocket lens being used if necessary, and the length of the seams and cavities is determined.

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Number of Tests.

9. Three test pieces shall be furnished from each plate as it is rolled; one for tension, one for cold bending and one for quench bending test. For rivet rods, two tensile test specimens and two cold bending and two quench bending test specimens shall be furnished from each melt. In case any one of these develops flaws, or should a tensile test specimen break outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor.

Permissible Variations.

10. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates.

WHEN ORDERED TO WEIGHT.

Plates 12½ pounds per square foot or heavier:

(*e*) Up to 100 inches wide, 2½ per cent. above or below the prescribed weight.

(*f*) 100 inches wide and over, 5 per cent. above or below.

Plates under 12½ pounds per square foot:

(*g*) Up to 75 inches wide, 2½ per cent. above or below.

(*h*) 75 inches and up to 100 inches wide, 5 per cent. above or 3 per cent. below.

(*i*) 100 inches wide and over, 10 per cent. above or 3 per cent. below

WHEN ORDERED TO GAUGE.

Plates will be accepted if they measure not more than 0.01 inch below the ordered thickness.

An excess over the nominal weight corresponding to the dimensions on the order will be allowed for each plate, if not more than that shown in the following tables, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

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Plates ¼ inch and over in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs. per sq. ft.	Width of Plate.			
		Up to 75 ins.	75 ins. and up to 100 ins.	100 ins. and up to 115 ins.	Over 115 ins.
1–4	10.20	10 per cent.	14 per cent.	18 per cent.	
5–16	12.75	8 "	12 "	16 "	
3–8	15.30	7 "	10 "	13 "	17 per cent.
7–16	17.85	6 "	8 "	10 "	13 "
1–2	20.40	5 "	7 "	9 "	12 "
9–16	22.95	4½ "	6½ "	8½ "	11 "
5–8	25.50	4 "	6 "	8 "	10 "
Over 5–8	.....	3½ "	5 "	6½ "	9 "

Plates under ¼ inch in thickness.

Thickness Ordered. Inches.	Nominal Weights. Lbs per sq. ft.	Width of Plate.		
		Up to 50 ins.	50 ins. and up to 70 ins.	Over 70 ins.
1–8 up to 5–32	5.10 to 6.37	10 per cent.	15 per cent.	20 per cent.
5–32 " 3–16	6.37 to 7.65	8½ "	12½ "	17 "
3–16 " 1–4	7.65 to 10.20	7 "	10 "	15 "

Branding. 11. Each plate shall be distinctly stamped with its heat or slab number, and with the name of the manufacturer, grade, and lowest tensile strength specified. Each test specimen shall be distinctly stamped with the heat or slab number which it represents.

Rivet steel may be shipped in securely fastened bundles with the melt number stamped on a metal tag attached.

Finish. 12. All finished material shall be free from injurious surface defects and laminations, and must have a workmanlike finish.

Inspection. 13. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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STANDARD SPECIFICATIONS FOR WROUGHT IRON.

ADOPTED AUGUST 10, 1901.

1. Wrought iron shall be made by the puddling or by the charcoal hearth process or rolled from fagots or piles made from wrought-iron scrap, alone or with muck bar added. **Manufacture.**

2. The minimum physical qualities required in the four classes of wrought iron shall be as follows: **Tensile Test.**

Properties Considered.	Staybolt iron.	Merchant iron. Grade A.	Merchant iron. Grade B.	Merchant iron. Grade C.
Tensile strength, pounds per sq. in.	46,000	50,000	48,000	48,000
Yield point, pounds per sq. in.....	25,000	25,000	25,000	25,000
Elongation, per cent. in 8 ins.....	28	25	20	20

3. In sections weighing less than 0.654 pound per lineal foot, the percentage of elongation required in the four classes specified in Paragraph 2 shall be 21 per cent., 18 per cent., 15 per cent., and 12 per cent., respectively.

4. The four classes of iron when nicked and tested as described in Paragraph 9 shall show the following fracture: **Nicking Test.**

(*a*) Staybolt iron: a long, clean, silky fiber, free from slag or dirt, and wholly fibrous, being practically free from crystalline spots.

(*b*) Merchant iron, Grade A: a long, clean, silky fiber, free

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from slag or dirt or any coarse crystalline spots. A few fine crystalline spots may be tolerated, provided they do not in the aggregate exceed 10 per cent. of the sectional area of the bar.

(*c*) Merchant iron, Grade B: a generally fibrous fracture, free from coarse crystalline spots. Not over 10 per cent. of the fractured surface shall be granular.

(*d*) Merchant iron, Grade C: a generally fibrous fracture, free from coarse crystalline spots. Not over 15 per cent. of the fractured surface shall be granular.

Cold Bending Test.

5. The four classes of iron, when tested as described in Paragraph 10, shall conform to the following cold bending tests:

(*e*) Staybolt iron: A piece of staybolt iron about 24 inches long shall bend in the middle through 180° flat on itself, and then bend in the middle through 180° flat on itself in a plane at a right angle to the former direction, without a fracture on the outside of the bent portions. Another specimen with a thread cut over the entire length shall stand this double bending without showing deep cracks in the threads.

(*f*) Merchant iron, Grade A, shall bend cold 180° flat on itself without fracture on the outside of the bent portion.

(*g*) Merchant iron, Grade B, shall bend cold 180° around a diameter equal to the thickness of the specimen tested, without fracture on the outside of the bent portion.

(*h*) Merchant iron, Grade C, shall bend cold 180° around a diameter equal to twice the thickness of the specimen tested, without fracture on the outside of the bent portion.

Hot Bending Test.

6. The four classes of iron, when tested as described in Paragraph 11, shall conform to the following hot bending tests:

(*i*) Staybolt iron shall bend through 180° flat on itself, without showing cracks or flaws. A similar specimen heated to a yellow heat and suddenly quenched in water between 80° and 90° F., shall bend, without hammering on the bend, 180° flat on itself without showing cracks or flaws.

(*j*) Merchant iron, Grade A, shall bend through 180° flat on itself, without showing cracks or flaws. A similar specimen heated to a yellow heat and suddenly quenched in water between 80° and 90° F., shall bend, without hammering on the bend, 180° flat on itself without showing cracks or flaws. A similar specimen heated to a bright red heat, shall be split at the end and each part

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bent back through an angle of 180°. It will also be quenched and expanded by drifts until a round hole is formed whose diameter is not less than nine-tenths of the diameter of the rod or width of the bar. Any extension of the original split or indications of fracture, cracks, or flaws developed by the above tests will be sufficient cause for the rejection of the lot represented by that rod or bar.

(*k*) Merchant iron, Grade B, shall bend through 180° flat on itself, without showing cracks or flaws.

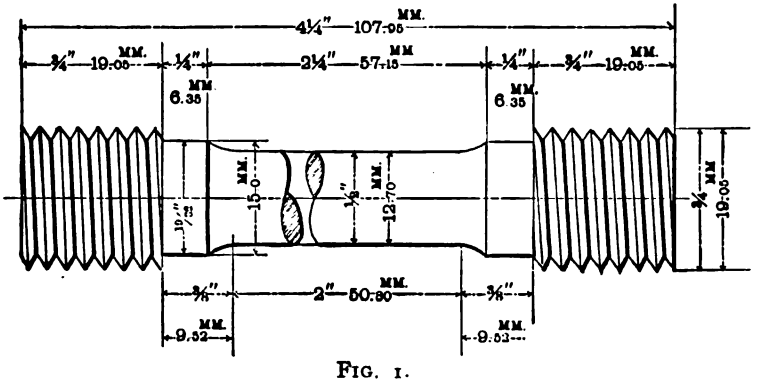
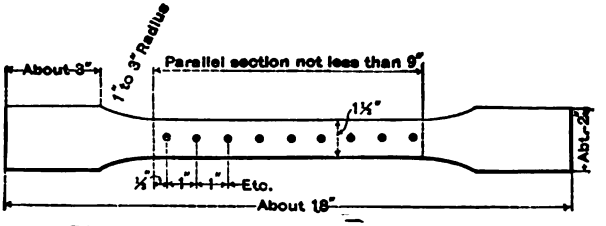


FIG. 1.



Piece to be of Same Thickness as the Plate.

FIG. 2.

(*l*) Merchant iron, Grade C, shall bend sharply to a right angle, without showing cracks or flaws.

7. Staybolt iron shall permit of the cutting of a clean sharp thread and be rolled true to gauges desired, so as not to jam in the threading dies. **Threading Test.**

8. Whenever possible, iron shall be tested in full size as rolled, to determine the physical qualities specified in Paragraphs 2 and 3, the elongation being measured on an 8-inch gauged length. In flats **Test Specimen for Tensile Test.**

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and shapes too large to test as rolled, the standard test specimen shall be 1½ inches wide and 8 inches gauged length.

In large rounds, the standard test specimen of 2 inches gauged length shall be used; the center of this specimen shall be half-way between the center and outside of the round. Sketches of these two standard test specimens are shown in Figs. 1 and 2.

Nicking Tests. 9. Nicking tests shall be made on specimens cut from the iron as rolled. The specimen shall be slightly and evenly nicked on one side and bent back at this point through an angle of 180° by a succession of light blows.

Cold Bending Tests. 10. Cold bending tests shall be made on specimens cut from the bar as rolled. The specimen shall be bent through an angle of 180° by pressure or by a succession of light blows.

Hot Bending Tests. 11. Hot bending tests shall be made on specimens cut from the bar as rolled. The specimens, heated to a bright red heat, shall be bent through an angle of 180° by pressure or by a succession of light blows and without hammering directly on the bend.

If desired, a similar bar of any of the four classes of iron shall be worked and welded in the ordinary manner without showing signs of red shortness.

Yield Point. 12. The yield point specified in Paragraph 2 shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

Finish. 13. All wrought iron must be practically straight, smooth, free from cinder spots or injurious flaws, buckles, blisters or cracks.

In round iron, sizes must conform to the Standard Limit gauge as adopted by the Master Car Builders' Association in November, 1883.

Inspection. 14. Inspectors representing the purchasers shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STAYBOLT IRON.

ADOPTED SEPTEMBER 1, 1910.

PROCESS OF MANUFACTURE.

All staybolt iron must be hammered or rolled from a bloom or a box-pile having a cross-sectional area of at least 45 sq. ins., and not less than 18 ins. long, the basis of which must be pig metal and entirely free from any admixture of steel.

PHYSICAL TESTS.

(*a*) *Tensile Strength.*—Not less than 48,000 lbs. per sq. in.

(*b*) *Elongation.*—Not less than 28 per cent. in 8 ins.

(*c*) *Reduction of Area.*—Not less than 45 per cent.

(*d*) *Double Bending Test.*—Close in both directions without flaws.

(*e*) *Nick and Break Test.*—A bar, nicked all around to a depth not less than 8 per cent. and not more than 16 per cent. of the diameter of the bar, and broken, shall show a clean fiber entirely free from crystallization.

(*f*) *Vibration Test.*—The test bar shall stand a minimum of 6,000 revolutions when subjected to the following vibratory test:

A threaded specimen, fixed at one end, has the other end moved in a circular path while stressed with a tensile load of 4,000 lbs. The circle described shall have a radius of $\frac{3}{8\frac{1}{2}}$ in. at a point 8 ins. from the fixed end of the specimen.

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INSPECTION.

(*a*) The iron must be smoothly rolled and free from slivers, depressions, seams, crop ends and evidences of being burnt.

(*b*) It must be truly round within 0.01 in., and must not be more than 0.005 in. above, or more than 0.01 in. below specified sizes.

SELECTION OF SAMPLES FOR TEST.

The bars will be sorted into lots of 100 bars each and two bars will be selected at random from each pile. Failure of either of these bars to meet any of the above specifications will be cause for rejection of the lot which the tests represent.

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PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR FOUNDRY PIG IRON.*

ADOPTED AUGUST 16, 1909.

PERCENTAGES AND VARIATIONS.

In order that there may be uniformity in grading, the following percentages and variations shall be used.†

Silicon.		*Sulphur.*	
Per cent.	Code.	Per cent.	Code.
1.00	La	0.04	Sa
1.50	Le	0.05	Se
2.00	Li	0.06	Si
2.50	Lo	0.07	So
3.00	Lu	0.08	Su
3.50	Ly	0.09	Sy
		0.10	Sh
(0.25 allowed either way.)		(Maximum.)	

Total Carbon		*Manganese.*		*Phosphorus.*	
Per cent.	Code.	Per cent.	Code.	Per cent.	Code.
3.00	Ca	0.20	Ma	0.20	Pa
3.20	Ce	0.40	Me	0.40	Pe
3.40	Ci	0.60	Mi	0.60	Pi
3.60	Co	0.80	Mo	0.80	Po
3.80	Cu	1.00	Mu	1.00	Pu
		1.25	My	1.25	Py
		1.50	Mh	1.50	Ph
(Minimum.)		(0.20 allowed either way.)		(0.15 allowed either way.)	

* It is recommended that foundry pig iron be bought by analysis, and that when so bought these Standard Specifications be used.

† These specifications do not advise that all five elements be specified in all contracts for pig iron, but do recommend that when these elements are specified, the given percentages shall be used.

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Illustration of the use of above coding: The word Li-se-ca-mo-pi indicates

Sil.	Sul.	Carb.	Mang.	Phos.
2.00	0.05	3.00	0.80	0.60

with variations as allowed.

Percentages of any element specified half way between the above shall be designated by the addition of the letter X to the next lower symbol.

Example.—PeX indicates Phosphorus 0.50, with "allowed" variations (0.15) up and down.

In the case of phosphorus and manganese, the percentages may be used as maximum or minimum figures, but unless so specified they will be considered to include the variations above given.

SAMPLING AND ANALYSIS.

Each car load, or its equivalent, shall be considered as a unit in sampling.

One sample shall be taken to every four tons in the car, and shall be so chosen from different parts of the car as to represent as nearly as possible the average quality of the iron.

Drillings shall be taken so as to fairly represent the composition of the pig as cast.

An equal weight of the drillings from each pig shall be thoroughly mixed to make up the sample for analysis.

In case of dispute, the sampling and analysis shall be made by an independent chemist, mutually agreed upon, if practicable, at the time the contract is made.

It is recommended that the standard methods of the American Foundrymen's Association be used for analysis. Gravimetric methods shall be used for the analysis of sulphur, unless otherwise specified in the contract.

The cost of re-sampling and re-analysis shall be borne by the party in error.

BASE OR QUOTING PRICE.

For market quotations, an iron of 2.00 per cent. in silicon (with variations of 0.25 either way) and 0.05 per cent. in sulphur (maximum) shall be taken as the base.

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THE AMERICAN FOUNDRYMEN'S ASSOCIATION SUGGESTS THE FOLLOWING CLAUSES FOR THE PURPOSE OF ADJUSTING DISPUTES BETWEEN BUYER AND SELLER.

Base Table.—The following table may be filled out, and may become a part of the contract. "B", or Base, represents the price agreed upon for a pig iron running 2.00 per cent. in silicon (with allowed variation of 0.25 either way) and under 0.05 per cent. in sulphur; "C" is a constant differential to be determined at the time the contract is made.

This table is for settling any differences which may arise in filling a contract, as explained under penalties and allowances, and may be used to regulate the price of a grade of pig iron which the purchaser desires, and the seller agrees, to substitute for the one originally specified.

Silicon percentages allow 0.25 variation either way. Sulphur percentages are maximum.

Sulphur, per cent.	*Silicon, per cent.*									
	3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00
0.04..	B+6C	B+5C	B+4C	B+3C	B+2C	B+1C	B	B−1C	B−2C	B−3C
0.05..	B+5C	B+4C	B+3C	B+2C	B+1C	B	B−1C	B−2C	B−3C	B−4C
0.06..	B+4C	B+3C	B+2C	B+1C	B	B−1C	B−2C	B−3C	B−4C	B−5C
0.07..	B+3C	B+2C	B+1C	B	B−1C	B−2C	B−3C	B−4C	B−5C	B−6C
0.08..	B+2C	B+1C	B	B−1C	B−2C	B−3C	B−4C	B−5C	B−6C	B−7C
0.09..	B+1C	B	B−1C	B−2C	B−3C	B−4C	B−5C	B−6C	B−7C	B−8C
0.10..	B	B−1C	B−2C	B−3C	B−4C	B−5C	B−6C	B−7C	B−8C	B−9C

Penalties.—In case the iron, when delivered, does not conform to the specifications, the buyer shall have the option of either refusing the iron, or accepting it on the basis shown in the above table, which must be filled out at the time the contract is made.

Allowances.—In case the furnace cannot, for any good reason, deliver the iron as specified at the time delivery is due, the purchaser may at his option accept any other analysis which the furnace can deliver, the price to be determined by the base table above, which must be filled out at the time the contract is made.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE AND SPECIAL CASTINGS.

ADOPTED NOVEMBER 15, 1904.

DESCRIPTIONS OF PIPES.

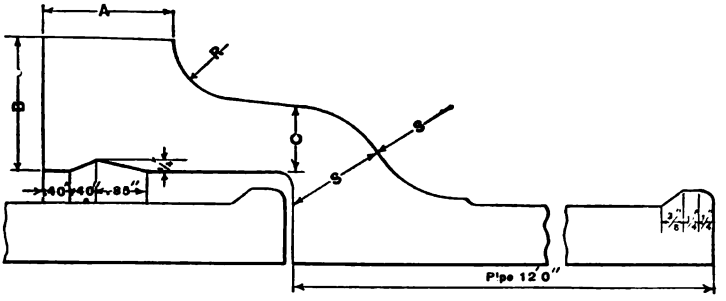
SECTION 1. The pipes shall be made with hub and spigot joints, and shall accurately conform to the dimensions given in Tables I and II. They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter. They shall be at least 12 feet in length, exclusive of socket. For pipes of each size from 4-inch to 24-inch, inclusive, there shall be two standards of outside diameter, and for pipes from 30-inch to 60-inch, inclusive, there shall be four standards of outside diameter, as shown by Table II.

All pipes having the same outside diameter shall have the same inside diameter at both ends. The inside diameter of the lighter pipes of each standard outside diameter shall be gradually increased for a distance of about 6 inches from each end of the pipe so as to obtain the required standard thickness and weight for each size and class of pipe.

Pipes whose standard thickness and weight are intermediate between the classes in Table II shall be made of the same outside diameter as the next heavier class. Pipes whose standard thickness and weight are less than shown by Table II shall be

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TABLE I.—GENERAL DIMENSIONS OF PIPES.



Nominal Diam., ins.	Classes	Actual Outside Diam., ins.	Diam. of Sockets.		Depth of Sockets.		A	B	C
			Pipe, ins.	Special Castings, ins.	Pipe, ins.	Special Castings, ins.			
4	A—B	4.80	5.60	5.70	3.50	4.00	1.5	1.30	0.65
4	C—D	5.00	5.80	5.70	3.50	4.00	1.5	1.30	0.65
6	A—B	6.90	7.70	7.80	3.50	4.00	1.5	1.40	0.70
6	C—D	7.10	7.90	7.80	3.50	4.00	1.5	1.40	0.70
8		9.05	9.85	10.00	4.00	4.00	1.5	1.50	0.75
8	C—D	9.30	10.10	10.00	4.00	4.00	1.5	1.50	0.75
10	A—B	11.10	11.90	12.10	4.00	4.00	1.5	1.50	0.75
10	C—D	11.40	12.20	12.10	4.00	4.00	1.5	1.60	0.80
12	A—B	13.20	14.00	14.20	4.00	4.00	1.5	1.60	0.80
12	C—D	13.50	14.30	14.20	4.00	4.00	1.5	1.70	0.85
14	A—B	15.30	16.10	16.10	4.00	4.00	1.5	1.70	0.85
14	C—D	15.65	16.45	16.45	4.00	4.00	1.5	1.80	0.90
16	A—B	17.40	18.40	18.40	4.00	4.00	1.75	1.80	0.90
16	C—	17.80	18.80	18.80	4.00	4.00	1.75	1.90	1.00
18	A—B	19.50	20.50	20.50	4.00	4.00	1.75	1.90	0.95
18	C—D	19.92	20.92	20.92	4.00	4.00	1.75	2.10	1.05
20	A—B	21.60	22.60	22.60	4.00	4.00	1.75	2.00	1.00
20	C—D	22.06	23.06	23.06	4.00	4.00	1.75	2.30	1.15
24	A—B	25.80	26.80	26.80	4.00	4.00	2.00	2.10	1.05
24	C—D	26.32	27.32	27.32	4.00	4.00	2.00	2.50	1.25
30	A	31.74	32.74	32.74	4.50	4.50	2.00	2.50	1.15
30	B	32.00	33.00	33.00	4.50	4.50	2.00	2.30	1.15
30	C	32.40	33.40	33.40	4.50	4.50	2.00	2.60	1.32
30	D	32.74	33.74	33.74	4.50	4.50	2.00	3.00	1.50
36	A	37.96	38.96	38.96	4.50	4.50	2.00	2.50	1.25
36	B	38.30	39.30	39.30	4.50	4.50	2.00	2.80	1.40
36	C	38.70	39.70	39.70	4.50	4.50	2.00	3.10	1.60
36	D	39.16	40.16	40.16	4.50	4.50	2.00	3.40	1.80
42	A	44.20	45.20	45.20	5.00	5.00	2.00	2.80	1.40
42	B	44.55	45.50	45.50	5.00	5.00	2.00	3.00	1.50
42	C	45.10	46.10	46.10	5.00	5.00	2.00	3.40	1.75
42	D	45.58	46.58	46.58	5.00	5.00	2.00	3.80	1.95
48	A	50.50	51.50	51.50	5.00	5.00	2.00	3.00	1.50

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TABLE I.—(CONTINUED.)

Nominal Diam., ins.	Classes.	Actual Outside Diam., ins.	Diam. of Sockets.		Depth of Sockets.		A	B	C
			Pipe, ins.	Special Castings, ins.	Pipe, ins.	Special Castings, ins.			
48	B	50.80	51.80	51.80	5.00	5.00	2.00	3.30	1.65
48	C	51.40	52.40	52.40	5.00	5.00	2.00	3.80	1.95
48	D	51.98	52.98	52.98	5.00	5.00	2.00	4.20	2.20
54	A	56.66	57.66	57.66	5.50	5.50	2.25	3.20	1.60
54	B	57.10	58.10	58.10	5.50	5.50	2.25	3.60	1.80
54	C	57.80	58.80	58.80	5.50	5.50	2.25	4.00	2.15
54	D	58.40	59.40	59.40	5.50	5.50	2.25	4.40	2.45
60	A	62.80	63.80	63.80	5.50	5.50	2.25	3.40	1.70
60	B	63.40	64.40	64.40	5.50	5.50	2.25	3.70	1.90
60	C	64.20	65.20	65.20	5.50	5.50	2.25	4.20	2.25
60	D	64.82	65.82	65.82	5.50	5.50	2.25	4.70	2.60

made of the same outside diameter as the Class A pipes, and pipes whose thickness and weight are more than shown by Table II shall be made of the same outside diameter as the Class D pipes.

For pipes 4-inch to 12-inch, inclusive, one class of special castings shall be furnished, made from Class D pattern. Those having spigot ends shall have outside diameters of spigot ends midway between the two standards of outside diameter as shown by Table II, and shall be tapered back for a distance of 6 inches. For pipes from 14-inch to 24-inch, inclusive, two classes of special castings shall be furnished, Class B special castings with Classes A and B pipes, and Class D special castings with Classes C and D pipes, the former to be stamped "AB" and the latter to be stamped "CD." For pipes 30-inch to 60-inch, inclusive, four classes of special castings shall be furnished, one for each class of pipe, and shall be stamped with the letter of the class to which they belong.

ALLOWABLE VARIATION IN DIAMETER OF PIPES AND SOCKETS.

SECTION 2. Especial care shall be taken to have the sockets of the required size. The sockets and spigots will be tested by circular gauges, and no pipe will be received which is defective in joint room from any cause. The diameters of the sockets and the outside diameters of the bead ends of the pipes shall not vary

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TABLE II.—STANDARD THICKNESSES AND WEIGHTS OF CAST-IRON PIPE.

Nominal Inside Diam., ins.	CLASS A. 100 FT. HEAD. 43 LBS. PRESSURE.			CLASS B. 200 FT. HEAD. 86 LBS. PRESSURE.			CLASS C. 300 FT. HEAD. 130 LBS. PRESSURE.			CLASS D. 400 FT. HEAD. 173 LBS. PRESSURE.			Nominal Inside Diam., ins.
	Thickness, ins.	Weight per		Thickness, ins.	Weight per		Thickness, ins.	Weight per		Thickness, ins.	Weight per		
		Foot.	Length.		Foot.	Length.		Foot.	Length.		Foot.	Length.	
4	0.42	20.0	240	0.45	21.7	260	0.48	23.3	280	0.52	25.0	300	4
6	0.44	30.8	370	0.48	33.3	400	0.51	35.8	430	0.55	38.3	460	6
8	0.46	42.9	515	0.51	47.5	570	0.56	52.1	625	0.60	55.8	670	8
10	0.50	57.1	685	0.57	63.8	765	0.62	70.8	850	0.68	76.7	920	10
12	0.54	72.5	870	0.62	82.1	985	0.68	91.7	1,100	0.75	100.0	1,200	12
14	0.57	80.6	1,075	0.66	102.5	1,230	0.74	116.7	1,400	0.82	129.2	1,550	14
16	0.60	108.3	1,300	0.70	125.0	1,500	0.80	143.8	1,725	0.89	158.3	1,900	16
18	0.64	120.2	1,550	0.75	150.0	1,800	0.87	175.0	2,100	0.96	191.7	2,300	18
20	0.67	150.0	1,800	0.80	175.0	2,100	0.92	208.3	2,500	1.03	229.2	2,750	20
24	0.76	204.2	2,450	0.89	233.3	2,800	1.04	279.2	3,350	1.16	306.7	3,680	24
30	0.88	291.7	3,500	1.03	333.3	4,000	1.20	400.0	4,800	1.37	450.0	5,400	30
36	0.99	391.7	4,700	1.15	454.2	5,450	1.30	545.8	6,550	1.58	625.0	7,500	36
42	1.10	512.5	6,150	1.28	591.7	7,100	1.54	716.7	8,600	1.78	825.0	9,900	42
48	1.26	666.7	8,000	1.42	750.0	9,000	1.71	908.3	10,900	1.96	1,050.0	12,600	48
54	1.35	800.0	9,600	1.55	933.3	1,200	1.90	1,141.7	13,700	2.23	1,341.7	16,100	54
60	1.39	916.7	11,000	1.67	1,104.2	13,250	2.00	1,341.7	16,100	2.38	1,583.3	19,000	60

The above weights are for 12 feet laying lengths and standard sockets; proportionate allowance to be made for any variation therefrom.

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from the standard dimensions by more than 0.06 inch for pipes 16 inches or less in diameter; 0.08 inch for 18-inch, 20-inch and 24-inch pipes; 0.10 inch for 30-inch, 36-inch and 42-inch pipes; 0.12 inch for 48-inch pipes; and 0.15 inch for 54-inch and 60-inch pipes.

ALLOWABLE VARIATION IN THICKNESS.

SECTION 3. For pipes whose standard thickness is less than 1 inch, the thickness of metal in the body of the pipe shall not be more than 0.08 inch less than the standard thickness; and for pipes whose standard thickness is 1 inch or more, the variation shall not exceed 0.10 inch, except that for spaces not exceeding 8 inches in length in any direction, variations from the standard thickness of 0.02 inch in excess of the allowance above given shall be permitted.

For special castings of standard patterns a variation of 50 per cent. greater than allowed for straight pipe shall be permitted.

DEFECTIVE SPIGOTS MAY BE CUT.

SECTION 4. Defective spigot ends on pipes 12 inches or more in diameter may be cut off in a lathe, and a half-round wrought-iron band shrunk into a groove cut in the end of the pipe. Not more than 12 per cent. of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 feet in length, exclusive of the socket.

In case the length of a pipe differs from 12 feet, the standard weight of the pipe given in Table II shall be modified in accordance therewith.

SPECIAL CASTINGS.

SECTION 5. All special castings shall be made in accordance with the cuts and the dimensions given in the table forming a part of these specifications.

The diameters of the sockets and the external diameters of the bead ends of the special castings shall not vary from the standard dimensions by more than 0.12 inch for castings 16 inches or less in diameter; 0.15 inch for 18-inch, 20-inch and 24-inch pipes; 0.20 inch for 30-inch, 36-inch and 42-inch pipes; and 0.24 inch for 48-inch, 54-inch and 60-inch pipes. These variations apply only to special castings made from standard patterns.

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The flanges on all manhole castings and manhole covers shall be faced true and smooth, and drilled to receive bolts of the sizes given in the tables. The manufacturer shall furnish and deliver all bolts for bolting on the manhole covers, the bolts to be of the sizes shown on plans and made of the best quality of mild steel, with hexagonal heads and nuts and sound, well-fitting threads.

MARKING.

SECTION 6. Every pipe and special casting shall have distinctly cast upon it the initials of the maker's name. When cast especially to order, each pipe and special casting larger than 4-inch may also have cast upon it figures showing the year in which it was cast and a number signifying the order in point of time in which it was cast, the figures denoting the year being above and the number below, thus:

1901	1901	1901
1	2	3

etc., also any initials, not exceeding four, which may be required by the purchaser. The letters and figures shall be cast on the outside and shall be not less than 2 inches in length and $\frac{1}{8}$ inch in relief for pipes 8 inches in diameter and larger. For smaller sizes of pipes the letters may be 1 inch in length. The weight and the class letter shall be conspicuously painted in white on the inside of each pipe and special casting after the coating has become hard.

ALLOWABLE PERCENTAGE OF VARIATION IN WEIGHT.

SECTION 7. No pipe shall be accepted the weight of which shall be less than the standard weight by more than 5 per cent. for pipes 16 inches or less in diameter, and 4 per cent. for pipes more than 16 inches in diameter; and no excess above the standard weight of more than the given percentages for the several sizes shall be paid for. The total weight to be paid for shall not exceed for each size and class of pipe received the sum of the standard weights of the same number of pieces of the given size and class by more than 2 per cent.

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No special casting shall be accepted the weight of which shall be less than the standard weight by more than 10 per cent. for pipes 12 inches or less in diameter, and 8 per cent. for larger sizes, except that curves, Y-pieces and breeches pipe may be 12 per cent. below the standard weight, and no excess above the standard weight of more than the above percentages for the several sizes will be paid for. These variations apply only to castings made from the standard patterns.

QUALITY OF IRON.

SECTION 8. All pipes and special castings shall be made of cast iron of good quality, and of such character as shall make the metal of the castings strong, tough and of even grain, and soft enough to satisfactorily admit of drilling and cutting. The metal shall be made without any admixture of cinder iron or other inferior metal, and shall be remelted in a cupola or air furnace.

TESTS OF MATERIALS.

SECTION 9. Specimen bars of the metal used, each being 26 inches long by 2 inches wide and 1 inch thick, shall be made without charge as often as the engineer may direct, and, in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars, when placed flatwise upon supports 24 inches apart and loaded in the center, shall, for pipes 12 inches or less in diameter, support a load of 1,900 pounds and show a deflection of not less than 0.30 inch before breaking; and for pipes of sizes larger than 12 inches, they shall support a load of 2,000 pounds and show a deflection of not less than 0.32 inch. The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

CASTING OF PIPES.

SECTION 10. The straight pipes shall be cast in dry sand molds in a vertical position. Pipes 16 inches or less in diameter

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shall be cast with the hub end up or down, as specified in the proposal. Pipes 18 inches or more in diameter shall be cast with the hub end down.

The pipes shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

QUALITY OF CASTINGS.

SECTION 11. The pipes and special castings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging or filling will be allowed.

CLEANING AND INSPECTION.

SECTION 12. All pipes and special castings shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the engineer immediately before being dipped.

COATING.

SECTION 13. Every pipe and special casting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

Each casting shall be heated to a temperature of 300° F. immediately before it is dipped, and shall possess not less than this temperature at the time it is put in the vat. The ovens in which the pipes are heated shall be so arranged that all portions of the pipe shall be heated to an even temperature. Each casting shall remain in the bath at least five minutes.

The varnish shall be heated to a temperature of 300° F. (or less if the engineer shall so order), and shall be maintained at this temperature during the time the casting is immersed.

Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency, and the vat shall be emptied

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of its contents and refilled with fresh pitch when deemed necessary by the engineer. After being coated, the pipes shall be carefully drained of the surplus varnish. Any pipe or special casting that is to be re-coated shall first be thoroughly scraped and cleaned.

HYDROSTATIC TEST.

SECTION 14. When the coating has become hard, the straight pipes shall be subjected to a proof by hydrostatic pressure and, if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressure to which the different sizes and classes of pipes shall be subjected are as follows:

	20-Inch Diameter and Larger, lbs. per sq. in.	Less than 20-Inch Diameter, lbs. per sq. in.
Class A pipe	150	300
Class B pipe	200	300
Class C pipe	250	300
Class D pipe	300	300

WEIGHING.

SECTION 15. The pipes and special castings shall be weighed for payment under the supervision of the engineer after the application of the coal-tar pitch varnish. If desired by the engineer the pipes and special castings shall be weighed after their delivery, and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weighmaster. Bids shall be submitted and a final settlement made up on the basis of a ton of 2,000 pounds.

CONTRACTOR TO FURNISH MEN AND MATERIALS.

SECTION 16. The contractor shall provide all tools, testing machines, materials and men necessary for the required testing, inspection and weighing at the foundry of the pipes and special castings; and, should the purchaser have no inspector at the works, the contractor shall, if required by the engineer, furnish a sworn

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statement that all of the tests have been made as specified, this statement to contain the results of the tests upon the test bars.

POWER OF ENGINEER TO INSPECT.

SECTION 17. The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting and coating of the pipes and special castings. The forms, sizes, uniformity and conditions of all pipes and other castings herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipes or other casting which is not in conformity with the specifications or drawings.

INSPECTOR TO REPORT.

SECTION 18. The inspector at the foundry shall report daily to the foundry office all pipes and special castings rejected, with the causes for rejection.

CASTINGS TO BE DELIVERED SOUND AND PERFECT.

SECTION 19. All the pipes and other castings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the contractor of any of his obligations in this respect, and any defective pipe or other castings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered until the final completion and adjustment of the contract, provided, however, that the contractor shall not be held liable for pipes or special castings found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipes not to injure the coating, and no pipes or other material of any kind shall be placed in the pipes during transportation or at any time after they receive the coating.

DEFINITION OF THE WORD "ENGINEER."

SECTION 20. Wherever the word "engineer" is used herein, it shall be understood to refer to the engineer or inspector acting for the purchaser and to his properly authorized agents, limited by the particular duties intrusted to them.

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STANDARD SPECIFICATIONS FOR LOCOMOTIVE CYLINDERS.

ADOPTED NOVEMBER 15, 1904.

Process of Manufacture.

1. Locomotive cylinders shall be made from good quality of close-grained gray iron cast in a dry sand mold.

Chemical Properties.

2. Drillings taken from test pieces cast as hereafter mentioned shall conform to the following limits in chemical composition:

Silicon	from 1.25 to 1.75	per cent
Phosphorus	not over 0.9	"
Sulphur	" 0.10	"

Physical Properties.

3. The minimum physical qualities for cylinder iron shall be as follows:

The "Arbitration Test Bar," 1¼ inches in diameter, with supports 12 inches apart, shall have a transverse strength not less than 3,000 pounds, centrally applied, and a deflection not less than 0.10 inch.

Test Pieces and Method of Testing.

4. The standard test piece shall be 1¼ inches in diameter, about 14 inches long, cast on end in dry sand. The drillings for analysis shall be taken from this test piece, but in case of rejection the manufacturer shall have option of analyzing drillings from the bore of the cylinder, upon which analysis the acceptance or rejection of the cylinder shall be based.

One test piece for each cylinder shall be required.

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5. Castings shall be smooth, well cleaned, free from blowholes, shrinkage cracks or other defects, and must finish to blue-print size. **Character of Castings.**

Each cylinder shall have cast on each side of saddle, the manufacturer's mark, serial number, date made and mark showing order number.

6. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy himself that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of the manufacturer. **Inspection.**

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STANDARD SPECIFICATIONS FOR CAST-IRON CAR WHEELS.

ADOPTED SEPTEMBER 1, 1905.

Chemical Properties. The wheels furnished under this specification must be made from the best materials, and in accordance with the best foundry methods. The following pattern analysis is given for information, as representing the chemical properties of a good cast-iron wheel. Successful wheels, varying in some of the constituents quite considerably from the figures given, may be made:

Total carbon	3.50 per cent.
Graphitic carbon	2.90 "
Combined carbon	0.60 "
Silicon	0.70 "
Manganese	0.40 "
Phosphorus	0.50 "
Sulphur	0.08 "

1. Wheels will be inspected and tested at the place of manufacture.

2. All wheels must conform in general design and in measurements to drawings, which will be furnished, and any departure from the standard drawing must be by special permission in writing, and manufacturers wishing to deviate from the standard dimensions must submit duplicate drawings showing the proposed changes, which must be approved.

Drop Tests. 3. The following table gives data as to weight and tests of various kinds of wheels for different kinds of cars and service:

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Wheel	33-inch diameter Frgt. and Pass. cars.			36-inch diameter.	
Kind of service	60,000 lbs. capacity and less	70,000 lbs. capacity.	100,000 lbs. capacity.	Passenger Cars.	Locomotive Tenders.
Number	1	2	3	4	5
Weight, Desired	600	650	700	700 lbs.	750 lbs.
Weight, Variation	Two per cent. either way.				
Height of drop, ft.	9	12	12	12	12
Number of blows	10	10	12	12	14

Marking.

4. Each wheel must have plainly cast on the outside plate the name of the maker and place of manufacture. Each wheel must also have cast on the inside double plate the date of casting and a serial foundry number. The manufacturer must also provide for the guarantee mark, if so required by the contract. No wheel bearing a duplicate number, or a number which has once been passed upon, will be considered. Numbers of wheels once rejected will remain unfilled. No wheel bearing an indistinct number or date, or any evidence of an altered or defaced number will be considered.

Measures.

5. All wheels offered for inspection must have been measured with a standard tape measure and must have the shrinkage number stenciled in plain figures on the inside of the wheel. The standard tape measure must correspond in form and construction to the "Wheel Circumference Measure" established by the Master Car Builders' Association in 1900. The nomenclature of that measure need not, however, be followed, it being sufficient if the graduating marks indicating tape sizes are one-eighth of an inch apart. Any convenient method of showing the shrinkage or stencil number may be employed. Experience shows that standard tape measures elongate a little with use, and it is essential to have them frequently compared and rectified. When ready for inspection, the wheels must be arranged in rows according to shrinkage numbers, all wheels of the same date being grouped together. Wheels bearing dates more than thirty days prior to the date of inspection will not be accepted for test, except by permission. For any single inspection and test only wheels having

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three consecutive shrinkage or stencil numbers will be considered. The manufacturer will, of course, decide what three shrinkage or stencil numbers he will submit in any given lot of 103 wheels offered, and the same three shrinkage or stencil numbers need not be offered each time.

Finish. 6. The body of the wheels must be smooth and free from slag and blowholes, and the hubs must be solid. Wheels will not be rejected because of drawing around the center core. The tread and throat of the wheels must be smooth, free from deep and irregular wrinkles, slag, sand wash, chill cracks or swollen rims, and be free from any evidence of hollow rims, and the throat and thread must be practically free from sweat.

Material and Chill. 7. Wheels tested must show soft, clean, gray iron, free from defects, such as holes containing slag or dirt more than one-quarter of an inch in diameter, or clusters of such holes, honeycombing of iron in the hub, white iron in the plates or hub, or clear white iron around the anchors of chaplets at a greater distance than one-half of an inch in any direction. The depth of the clear white iron must not exceed seven-eighths of an inch at the throat and one inch at the middle of the tread, nor must it be less than three-eighths of an inch at the throat or any part of the tread. The blending of the white iron with the gray iron behind must be without any distinct line of demarcation, and the iron must not have a mottled appearance in any part of the wheel at a greater distance than one and five-eighths inches from the tread or throat. The depth of chill will be determined by inspection of the three test wheels described below, all test wheels being broken for this purpose, if necessary. If one only of the three test wheels fails in limits of chill, all the lot under test of the same shrinkage or stencil number will be rejected and the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects as constituents of another 103 wheels for a subsequent test. If two of the three test wheels fail in limits of chill, the wheels in the lot of 103 of the same shrinkage or stencil number as these two wheels will be rejected, and, as before, the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the third shrinkage or

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stencil number, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test. If all three test wheels fail in limits of chill, of course the whole hundred will be rejected.

Inspection and Shipping.

8. The manufacturer must notify when he is ready to ship not less than 100 wheels; must await the arrival of the inspector; must have a car, or cars, ready to be loaded with the wheels, and must furnish facilities and labor to enable the inspector to inspect, test, load and ship the wheels promptly. Wheels offered for inspection must not be covered with any substance which will hide defects.

9. A hundred or more wheels being ready for test, the inspector will make a list of the wheel numbers, at the same time examining each wheel for defects. Any wheels which fail to conform to specifications by reason of defects must be laid aside, and such wheels will not be accepted for shipment. As individual wheels are rejected, others of the proper shrinkage, or stencil number, may be offered to keep the number good.

Retaping.

10. The inspector will retape not less than 10 per cent of the wheels offered for test, and if he finds any showing wrong tape-marking, he will tape the whole lot and require them to be restenciled, at the same time having the old stencil marks obliterated. He will weigh and make check measurements of at least 10 per cent. of the wheels offered for test, and if any of these wheels fail to conform to the specification, he will weigh and measure the whole lot, refusing to accept for shipment any wheels which fail in these respects.

Drop Tests.

11. Experience indicates that wheels with higher shrinkage or lower stencil numbers are more apt to fail on thermal test; more apt to fail on drop test, and more apt to exceed the maximum allowable chill than those with higher stencil or lower shrinkage numbers; while, on the other hand, wheels with higher stencil or lower shrinkage numbers are more apt to be deficient in chill. For each 103 wheels apparently acceptable, the inspector will select three wheels for test—one from each of the three shrinkage or stencil numbers offered. One of these wheels chosen for this purpose by the inspector must be tested by drop test as follows: The wheel must be placed flange downward in an anvil block weighing not less than 1,700 pounds, set on rubble masonry two

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feet deep and having three supports not more than five inches wide for the flange of the wheel to rest on. It must be struck centrally upon the hub by a weight of 200 pounds, falling from a height as shown in the table in Section 3. The end of the falling weight must be flat, so as to strike fairly on the hub, and when by wear the bottom of the weight assumes a round or conical form, it must be replaced. The machine for making this test is shown on drawings which will be furnished. Should the wheel stand without breaking in two or more pieces, the number of blows, shown in the above table, the one hundred wheels represented by it will be considered satisfactory as to this test. Should it fail, the whole hundred will be rejected.

Thermal Test. 12. The other two test wheels must be tested as follows: The wheels must be laid flange down in the sand, and a channelway one and one-half inches in width at the center of the tread and four inches deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of this channelway, and the clean flange must form as much of the bottom as its width will cover. The channelway must then be filled to the top from one ladle with molten cast iron, which must be poured directly into the channelway without previous cooling or stirring, and this iron must be so hot, when poured, that the ring which is formed when the metal is cold shall be solid or free from wrinkles or layers. Iron at this temperature will usually cut a hole at the point of impact with the flange. In order to avoid spitting during the pouring, the tread and inside of the flange during the thermal test should be covered with a coat of shellac; wheels which are wet or which have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances must the thermal test be applied to a wheel that in any part feels warm to the hand. The time when pouring ceases must be noted, and two minutes later an examination of the wheel under test must be made. If the wheel is found broken in pieces, or if any crack in the plates extends through or into the tread, the test wheel will be regarded as having failed. If both wheels stand, the whole hundred will be accepted as to this test. If both fail, the whole hundred will be rejected. If one only of the thermal test wheels fails, all of the lot under test of the same shrinkage or stencil number will be

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rejected, and the test will be regarded as finished, so far as this lot of wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test.

13. All wheels which pass inspection and test will be regarded as accepted, and may be either shipped or stored for future shipment, as arranged. It is desired that shipments should be, as far as possible, in lots of 100 wheels. In all cases the inspector must witness the shipment, and he must give, in his report, the numbers of all wheels inspected and the disposition made of them. **Storing and Shipping.**

14. Individual wheels will be considered to have failed and will not be accepted or further considered, which, **Rejections.**

First. Do not conform to standard design and measurement.

Second. Are under or over weight.

Third. Have the physical defects described in Section 6.

15. Each 103 wheels submitted for test will be considered to have failed and will not be accepted or considered further, if, **Rejections.**

First. The test wheels do not conform to Section 7, especially as to limits of white iron in the throat and tread and around chaplets.

Second. One of the test wheels does not stand the drop test as described in Section 11.

Third. Both of the two test wheels do not stand the thermal test as described in Section 12.

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STANDARD SPECIFICATIONS FOR GRAY-IRON CASTINGS.

ADOPTED SEPTEMBER 1, 1905.

Process of Manufacture.

1. Unless furnace iron is specified, all gray castings are understood to be made by the cupola process.

Chemical Properties.

2. The sulphur contents to be as follows:

Light castings	not over 0.08 per cent.
Medium castings	" 0.10 "
Heavy casting	" 0.12 "

Classification.

3. In dividing castings into light, medium and heavy classes, the following standards have been adopted:

Castings having any section less than ½-inch thick shall be known as *light castings.*

Castings in which no section is less than 2 inches thick shall be known as *heavy castings.*

Medium castings are those not included in the above classification.

Physical Properties.

4. *Transverse Test.* The minimum breaking strength of the "Arbitration Bar" under transverse load shall be not under:

Light castings	2,500 lbs.
Medium castings	2,900 "
Heavy castings	3,300 "

In no case shall the deflection be under 0.10 inch.

Tensile Test. Where specified, this shall not run less than:

Light castings	18,000 lbs. per sq. in.
Medium castings	21,000 " " "
Heavy castings	24,000 " " "

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5. The quality of the iron going into castings under specification shall be determined by means of the "Arbitration Bar." This is a bar 1¼ inches in diameter and 15 inches long. It shall be prepared as stated further on and tested transversely. The tensile test is not recommended, but in case it is called for, the bar as shown in Fig. 1, and turned up from any of the broken pieces of the transverse test shall be used. The expense of the tensile test shall fall on the purchaser. **Arbitration Bar.**

6. Two sets of two bars shall be cast from each heat, one set from the first and the other set from the last iron going into the castings. Where the heat exceeds twenty tons, an additional set **Number of Test Bars.**

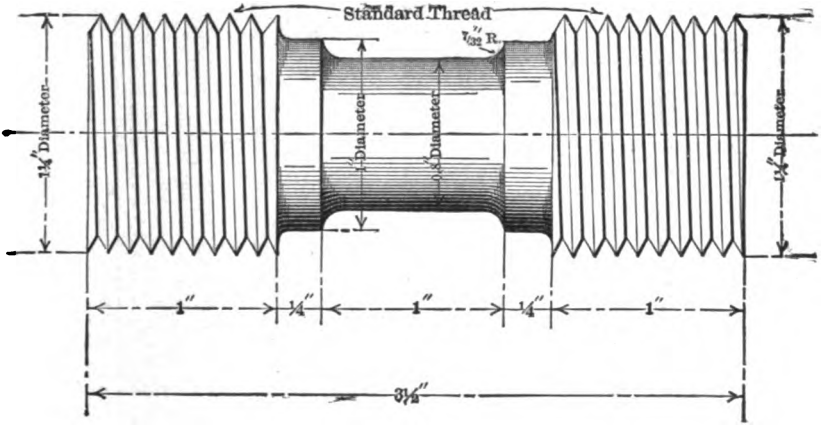


FIG. 1.—ARBITRATION TEST BAR. TENSILE TEST PIECE.

o two bars shall be cast for each twenty tons or fraction thereof above this amount. In case of a change of mixture during the heat, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars is to go into a single mold. The bars shall not be rumbled or otherwise treated, being simply brushed off before testing.

7. The transverse test shall be made on all the bars cast, with supports 12 inches apart, load applied at the middle, and the deflection at rupture noted. One bar of every two of each set made must fulfil the requirements to permit acceptance of the castings represented. **Method of Testing.**

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Mold for Test Bar.

8. The mold for the bars is shown in Fig. 2. The bottom of the bar is $\frac{1}{16}$ inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a little damper than usual, well mixed and

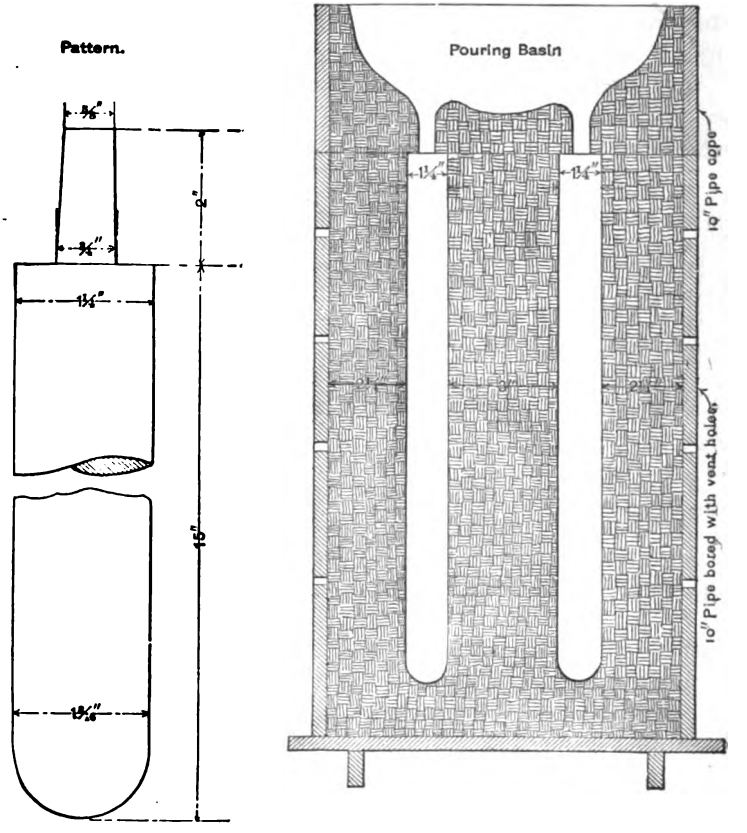


FIG. 2.—MOLD FOR ARBITRATION TEST BAR.

put through a No. 8 sieve, with a mixture of one to twelve bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled.

Speed of Testing.

9. The rate of application of the load shall be from 20 to 40 seconds for a deflection of 0.10 inch.

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10. Borings from the broken pieces of the "Arbitration Bar" shall be used for the sulphur determinations. One determination for each mold made shall be required. In case of dispute, the standards of the American Foundrymen's Association shall be used for comparison. **Samples for Analysis.**

11. Castings shall be true to pattern, free from cracks, flaws and excessive shrinkage. In other respects they shall conform to whatever points may be specially agreed upon. **Finish.**

12. The inspector shall have reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall, as far as possible, be made at the place of manufacture prior to shipment. **Inspection.**

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STANDARD SPECIFICATIONS FOR MALLEABLE CASTINGS.

ADOPTED NOVEMBER 15, 1904.

Process of Manufacture. 1. Malleable iron castings may be made by the open-hearth, air furnace, or cupola process. Cupola iron, however, is not recommended for heavy nor for important castings.

Chemical Properties. 2. Castings for which physical requirements are specified shall not contain over 0.06 sulphur nor over 0.225 phosphorus.

Physical Properties. 3. *Standard Test Bar.* This bar shall be 1 inch square and 14 inches long, without chills and with ends left perfectly free in the mold. Three shall be cast in one mold, heavy risers insuring sound bars. Where the full heat goes into castings which are subject to specification, one mold shall be poured two minutes after tapping into the first ladle, and another mold from the last iron of the heat. Molds shall be suitably stamped to insure identification of the bars, the bars being annealed with the castings. Where only a partial heat is required for the work in hand, one mold should be cast from the first ladle used and another after the required iron has been tapped.

(*a*) Of the three test bars from the two molds required for each heat, one shall be tested for tensile strength and elongation, the other for transverse strength and deflection. The other remaining bar is reserved for either the transverse or tensile test, in case of the failure of the two other bars to come up to requirements. The halves of the bars broken transversely may also be used for the tensile test.

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(*b*) Failure to reach the required limit for the tensile strength with elongation, as also the transverse strength with deflection, on the part of at least one test, rejects the castings from that heat.

4. *Tensile Test.* The tensile strength of a standard test bar for castings under specification shall not be less than 40,000 pounds per square inch. The elongation measured in 2 inches shall not be less than $2\frac{1}{2}$ per cent.

5. *Transverse Test.* The transverse strength of a standard test bar, on supports 12 inches apart, pressure being applied at center, shall not be less than 3,000 pounds, deflection being at least $\frac{1}{2}$ inch.

6. Castings of special design or of special importance may be provided with suitable test lugs at the option of the inspector. At least one of these lugs shall be left on the casting for his inspection upon his request therefor. **Test Lugs.**

7. Malleable castings shall neither be "over" nor "under" annealed. They must have received their full heat in the oven at least sixty hours after reaching that temperature. **Annealing.**

The "saggers" shall not be dumped until the contents shall at least be "black hot."

8. Castings shall be true to pattern, free from blemishes, scale or shrinkage cracks. A variation of $\frac{1}{16}$ inch per foot shall be permissible. Founders shall not be held responsible for defects due to irregular cross sections and unevenly distributed metal. **Finish.**

9. The inspector representing the purchaser shall have all reasonable facilities given him by the founder to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made prior to shipment. **Inspection.**

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PRACTICE RECOMMENDED FOR ANNEALING MISCELLANEOUS ROLLED AND FORGED CARBON-STEEL OBJECTS.

ADOPTED AUGUST 21, 1911.

1. *Purpose and General Procedure.*—The usual purpose in annealing miscellaneous forged or rolled carbon-steel objects is to remove existing coarseness of grain. This removal is brought about by heating the object to an annealing temperature, which varies with the carbon content of the metal. But the rate at which the object cools from this annealing temperature influences its properties very profoundly. Hence this rate of cooling should be suited to the duties which the object has to perform in service, and hence to the properties which we seek to give it.

Therefore these specifications first consider the annealing temperature to which the piece must be heated in order to remove existing coarse grain, and then the rate of cooling from that temperature.

Under certain special conditions an annealing is required in order to remove, not coarseness of grain, but the effects of rolling or otherwise working the metal at a temperature so low as to set up serious internal stress. Appropriate treatment for these conditions is given in Section 14.

As these specifications are intended to apply to a great variety of miscellaneous objects, they are purposely made suggestive rather than mandatory in many respects, because no single set of rules can be applied rigorously to such widely varying classes of objects and purposes.

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ANNEALING FOR REMOVING EXISTING COARSE GRAIN.

2. *Method of Heating.*—In the case of large objects, the heating of the interior of which lags behind that of the outside, though the early part of the heating may if desired be rapid, the final approach to the annealing temperature aimed at should be slow, so that the interior may be brought fully up to it without carrying the exterior far beyond it, because in general any needlessly high temperature is injurious, and tends to re-coarsen the grain. The temperature should be held long enough at the annealing point to insure that the whole of the interior reaches that point, and that the refining of the grain may become complete. An exposure of one hour should be long enough for pieces twelve inches thick. Thicker pieces need a longer heating.

3. *Control of Temperature. Pyrometers.*—For all important work in careful hands the use of some trustworthy pyrometer is strongly recommended. But most pyrometers should be checked frequently against some standard. For those who are unwilling to take this trouble it is safer to rely on a trained eye than on an unchecked pyrometer. The operator should have clearly before him the fact that no pyrometer indicates the temperature of the interior of the object heated, and that the temperature which most pyrometers indicate is one between the temperature of the outside of the object heated and the temperature of the flame which is supplying the heat. Wherever practicable the part of the pyrometer which is supposed to reach the temperature of the object heated should be in immediate contact with that object, and should be protected from the flame or other source of heat by a suitable insulation, as for instance by covering it with sand. In important cases the gas or other source of heat should be shut off for at least ten minutes before taking the observation.

4. *Control Without the Use of a Pyrometer.*—In working without a pyrometer and relying on the eye, the light surrounding the furnace should be dull, and should be kept as nearly constant as practicable, in order that the eye may not be misled by the changing contrasts between the surrounding light and that of the object heated. In particular, direct sunlight should be excluded, and any arc or other strong lights should be so placed that neither they themselves nor any concentrated part of their light is in the field of the operator's sight when he is estimating by eye the temperature

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of the objects to be annealed. Allowance should be made for the brighter surroundings by day than at night, and on sunny than on dark days.

5. *Magnetic Indications.*—The annealing temperature for steels containing between 0.50 and 0.90 per cent. of carbon is that at which the metal suddenly ceases to be magnetic. This fact may sometimes be used for the purpose of fixing or verifying the annealing temperature.

6. *Annealing Temperature.*—In general, the higher the carbon content the lower should be the annealing temperature. Hence different temperatures are given for different ranges of carbon content. Further, in order to bring the interior of large objects up to an effective annealing temperature, their outside may often be raised advantageously somewhat above that temperature. Hence for each range of carbon content a range of temperature is given. The upper limit of this range applied (1) to larger objects, and (2) to the lower part of the range of carbon content given.

The following ranges of temperature should be used for the several ranges of carbon content indicated. They refer to the usual moderate manganese content. For steels with a manganese content greater than 0.75 per cent. slightly lower temperatures suffice.

Range of Carbon Content.	*Range of Annealing Temperature.*
Less than 0.12 per cent.	875 to 925° C. (1607–1697° F.)
0.12 to 0.29 " "	840 " 870 " (1544–1598. ")
0.30 " 0.49 " "	815 " 840 " (1499–1544. ")
0.50 " 1.00 " "	790 " 815 " (1454–1499. ")

7. *Care in Heating.*—Care should be taken that all parts of the object reach the same temperature. To that end it may be necessary to mask from the heat, by means of bricks, the thinner part of objects of varying thickness. When the heating is nearly finished, these bricks may be removed. In particular the flame should never be allowed to touch any part of the object under treatment.

8. *Cooling.*—After the object has been held at the annealing temperature long enough to make its temperature nearly uniform throughout, and to complete the refining of the grain, it should be cooled in a way suited to its carbon content and to giving it the specific properties needed. The general principles are: first,

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the higher the carbon the slower should be the cooling; and second, the slower the cooling the softer and more ductile the metal will be, and the lower will be its tensile strength, elastic limit, and yield point. The greatest softness and ductility are obtained at a certain sacrifice of strength and elasticity, and the greatest strength and elasticity at a certain sacrifice of softness and ductility.

For most purposes neither of these extremes is desired, and it is not only sufficient as regards quality but economical to remove the object from the furnace as soon as it has been thoroughly annealed, and to allow it to cool in air, always completely protected not only from rain and snow but from sharp drafts of air. Objects containing more than 0.50 per cent. of carbon should cool more slowly till the color dies out, say at 500° C. (932° F.), as for instance by leaving them in the furnace. They may then be removed and cooled in air. Further, thin objects containing between 0.25 and 0.50 per cent. of carbon should be treated like those of 0.50 per cent. of carbon, unless they can be so massed together that their collective bulk will retard their cooling, so that they will collectively cool even in air with moderate slowness, like single large objects.

SPECIAL ANNEALING METHODS.

9. The foregoing methods are economical because they release the furnaces early for further use. In case special qualities are desired the following methods may be used.

10. *To Give the Greatest Softness and Ductility* of which the metal is capable, even at a certain sacrifice of strength and elastic limit, for instance for ease of machining or to resist a small number of severe distortions, the metal should be cooled slowly, either within the furnace, or in the case of large objects, under a cover of lime, clay, or other slow conductor of heat. The slower the cooling and the lower the temperature to which slow cooling is carried, the softer and weaker will the steel be. But for most cases for which even unusual softness and ductility are required, it suffices to remove the object from the furnace when it has become dead black, and to cool it thenceforth in air.

11. *To Give Great Tensile Strength and High Elastic Limit* even at a certain sacrifice of ductility, the cooling should be more rapid, the rapidity to be governed by the thickness and carbon

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content of the object. Thin objects and those with high carbon content cannot stand so rapid a cooling as thick and low-carbon ones, lest their ductility be too far sacrificed. For instance, thick objects with less than 0.50 per cent. of carbon may be cooled completely in air, of course protected from rain or snow. Objects with 0.50 per cent. of carbon or more, and thin objects with from 0.30 to 0.50 per cent. of carbon, may be cooled in air if their cooling is somewhat retarded, as for instance by massing them together, as happens in the case of rails.

12. *To Give an Unusually High Combination of Ductility with Tensile Strength and Elastic Limit. Water or Oil Quenching and Annealing.*—This process needs great care and intelligence, and should in general be used only by those familiar with high-grade steels. After holding at the annealing temperature suited to the particular steel, as indicated in Section 6, the object is quenched in oil, which should be kept in circulation. It may be quenched in water if its carbon content is so low and its shape so simple that it is not in danger of cracking or receiving permanently harmful stress. In any event the danger of such cracking and stress is lessened by removing the object from the oil or water before it has cooled completely, say when its temperature has fallen to 160° C. (320° F.). It should if possible not cool below 100° C. (212° F.) and certainly not below 20° C. (68° F.). The annealing should begin within a very few hours after the quenching and if possible without ever allowing the piece to cool below 100° C. (212° F.) and certainly not below 20° C. (68° F.).

The steel thus hardened should next be annealed by heating to a temperature suited for giving the properties needed. In general the higher this annealing goes, the more ductile will the steel become, and the lower will be its strength and elastic limit.

For very high elastic limit and tensile strength, anneal at 500° to 650° C. (932° to 1202° F.). In this case the ductility will be low. Some steels, such as watch-springs and shafting, are annealed at 350° C. Little commercial annealing is done below 500° C.

For intermediate tensile strength, elastic limit, and ductility, best suited to the majority of cases, anneal at 600° to 650° C. (1112° to 1202° F.).

For the greatest ductility, with good strength and elastic limit, anneal at from 725° to 750° C. (1337° to 1382° F.).

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The object should be held at this second annealing temperature long enough not only to allow its interior to reach it, but also to relieve the stress given in the water or oil quenching. For pieces of moderate thickness a four-hour exposure should suffice.

13. *To Give a Moderate Increase of Strength and Elastic Limit above that Given by a Simple Slow Cooling, without the Full Sacrifice of Ductility which a Simple Air Cooling would Cause.*—After holding at the annealing temperature suited to the carbon content, as indicated in Section 6, hasten the cooling till the object is at a dull red, say 650° C. (1202° F.), and henceforth cool slowly. The hastening of the cooling may be brought about in the case of thin objects in relatively shallow furnaces by opening the furnace door till the temperature falls to dull redness; or by running the objects out into the air on a movable car-bottom, and returning them to the furnace when they have cooled to dull redness; or even, in the case of objects with not over 0.30 per cent. carbon and not too thin, by a temporary immersion in oil or even water, followed by a return to the furnace. In cases in which such operations are to be performed frequently, special unfired chambers may be used for the final slow cooling, thus leaving the annealing furnaces proper available for their regular work. The results obtained in this way are not as good as those obtained with the method described in Section 11.

14. *Special Annealing to Remove the Effects of Rolling or Otherwise Working the Object in the Cold or at any Unduly Low Temperature.*—The object should be heated to about 775° C. (1427° F.) and cooled with a slowness which should increase with the thickness, i. e., the least dimension of the piece. In the case of thin plates a mere heating to 725° C. (1337° F.), followed immediately by slow cooling, should suffice. In the case of thick forgings, in which much time may be needed to allow severe stress to relieve itself, the sojourn at 775° C. (1427° F.) may be prolonged for several hours, though always at the cost of superficial decarburizing.

Such annealing for steel containing less than 0.15 per cent. carbon should be at 900° C. (1652° F.). Great brittleness may be caused by annealing very low carbon steel in the neighborhood of 700° C. (1292° F.), after cold working.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD MAGNETIC TESTS OF IRON AND STEEL.

ADOPTED AUGUST 21, 1911.

CORE LOSS.

The power consumption in electrical sheet steel when subjected to an alternating magnetization is known as the core loss. The standard core loss is the total power in watts consumed in each kilogram of material at a temperature of 25° C., when subjected to a harmonically varying induction having a maximum of 10,000 gausses and a frequency of 60 cycles per second, when measured as specified below. It is represented by the symbol $W_{10/60}$.

The ageing coefficient is the percentage change in the standard core loss after continued heating at 100° C. for 600 hours.

The standard core loss shall be measured under the following conditions:

The magnetic circuit consists of 10 kg. (22 lbs.) of the test material, cut with a sharp shear into strips 50 cm. ($19\frac{11}{16}$ ins.) long and 3 cm. ($1\frac{3}{16}$ ins.) wide, half parallel and half at right angles to the direction of rolling, made up into four equal bundles, two containing material parallel and two containing material at right angles to the direction of rolling, and finally built into the four sides of a square with butt joints and opposite sides consisting of material cut in the same manner. No insulation other than the natural scale of the material (except in the case of scale-free material) shall be used between laminations, but the corner joints shall be separated by tough paper 0.01 cm. (0.004 in.) thick.

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The magnetizing winding shall consist of four solenoids surrounding the four sides of the magnetic circuit and joined in series. A secondary coil shall be used for energizing the voltmeter and the potential coil of the wattmeter.

These solenoids shall be wound on a form of any non-magnetic non-conducting material of the following dimensions:

Inside cross-section.....4 by 4 cm.
Thickness of wall.....not over 0.3 cm.
Winding length.....42 cm.

The primary winding on each solenoid shall consist of 150 turns of copper wire uniformly wound over the 42-cm. length. The total resistance of the magnetizing winding shall be between 0.3 and 0.5 ohm. The secondary winding of 150 turns of copper wire on each solenoid shall be similarly wound beneath the primary winding. Its resistance shall not exceed 1 ohm.

A voltmeter and the voltage coil of a wattmeter shall be connected in parallel to the terminals of the secondary winding of the apparatus. The current coil of the wattmeter shall be connected in series with the primary winding.

A sine wave electromotive force shall be applied to the primary winding and adjusted until the voltage of the secondary circuit is given by the equation:

$$E = \frac{4 f N n B M}{4 l D 10^8}$$

in which

f = form factor of primary E.M.F. = 1.11 for sine wave
N = number of secondary turns = 600
n = number of cycles per second = 60
B = maximum induction = 10,000
M = total mass in grams = 10,000
l = length of strips in centimeters = 50
D = specific gravity = 7.5 for high-resistance steel
= 7.7 for low-resistance steel
E = 106.6 volts for high-resistance steel for sine voltage
= 103.8 volts for low-resistance steel for sine voltage

A specific gravity of 7.5 is assumed for all steels having a resistance of over 2 ohms per meter-gram, and 7.7 for all steels having a resistance of less than 2 ohms per meter-gram. These steels are designated as high- and low-resistance steels, respectively.

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The wattmeter gives the power consumed in the iron and the secondary circuit. The loss in the secondary circuit is given in terms of the total resistance and voltage. Subtracting this correction term from the total power gives the net power consumed in the steel as hysteresis and eddy current loss. Dividing this value by ten gives the core loss in watts per kilogram.

The Procedure.—1. Cut from the test material a number of strips 3 by 50 cm., half parallel and half at right angles to the direction of rolling.

2. Place on the balance a pile of strips weighing 2.5 kg. Add a second pile of the same kind, bringing the weight up to 5 kg. In each case the weight is taken to the nearest strip. Add in succession two piles of 2.5 kg. each, of the other kind of strips, bringing the weight up to 7.5 kg. and 10 kg. respectively.

3. Secure each bundle by string or tape (not wire) and insert in the apparatus as indicated.

4. Apply the alternating voltage to the primary coil and tap the joints together until the current has a minimum value, as shown by an ammeter in series. Then clamp the corners firmly by some suitable device.

5. Shunt the ammeter and adjust the primary current until the voltmeter indicates the proper value. This adjustment may be made by an auto-transformer, by varying the field of the alternator, or by both, but not by the insertion of resistance or inductance in the primary circuit. Simultaneously the frequency must be adjusted to 60 cycles.

6. Read the wattmeter.

7. Calculations. Subtract from the wattmeter reading the instrument losses, which will be constant for any set of instruments and voltage, and divide by 10. The result is the standard core loss.

NORMAL INDUCTION.

The normal magnetic induction is the induction produced by a magnetizing force in a given piece of magnetic material which has been previously demagnetized and then subjected to many reversals of the given magnetizing force.

Both the induction B and the magnetizing force H shall be expressed in terms of the C. G. S. electromagnetic unit (gauss).

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Sheet Metal.—The standard normal induction data for sheet material shall consist of the magnetizing forces corresponding to inductions of 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, 14,000, 16,000, 18,000, 20,000 gausses, or such as may be obtained without exceeding a magnetizing force of 200 gausses.

The following details are to be observed:

The test material shall consist of 5 kg. of the strips cut as indicated for the standard core loss test.

The magnetic circuit shall be a rectangle having the test material for one pair of opposite sides, and the same or different material for the other pair, which may be shorter. The joints at each corner are alternately butt and lap, or may be clamped on the edges.

The magnetomotive force is applied in two sections. The main magnetizing coils shall consist of two equal and uniformly wound solenoids surrounding the test material. The compensating coils shall consist of two solenoids surrounding the yoke strips.

The test coil surrounds the middle portion of each bundle of test material. Four other test coils of half the number of turns are placed over the test material, approximately midway between the yokes and the center. The two center test coils are joined in series and the four end test coils are joined in series. The corresponding ballistic deflections, due to these two test coils, are measures of the magnetic fluxes through the underlying portions of the magnetic circuit. By connecting the two test coils so that the induced electromotive forces oppose each other, and adjusting the current through the compensating magnetizing coils so that there is no resulting ballistic deflection, an approximate uniformity of flux is secured through the greater portion of the test material, and the induction may be measured ballistically in the regular manner. The magnetizing force when the flux is adjusted to uniformity is that calculated from the uniform winding of the main magnetizing solenoids.

The cross-section of the magnetic circuit is determined as in the standard core loss test.

Rods.—The standard test for rods for use in electromagnets shall consist of the magnetizing forces corresponding to inductions of 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, 14,000, 16,000, 18,000, 20,000 gausses, or such as may be obtained without exceeding a magnetizing force of 200 gausses.

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The standard test for rods intended for permanent magnets shall consist in the measurement of the magnetizing force, the residual induction, and the coercive force corresponding to a maximum induction of 14,000 gausses.

Standard tests shall be made by the Burrows compensated double yoke method (described in *Standard Electrical Engineer's Handbook*, and also in *Technical Paper No. 117 of the Bureau of Standards*).

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PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

ADOPTED AUGUST 21, 1911.

Material. 1. The material shall be copper of such quality and purity that, when drawn hard, it shall have the properties and characteristics herein required.

Shapes. 2. These specifications cover hard-drawn round wire, grooved trolley wire, figure-eight trolley wire, and hard-drawn cable or strand, as hereinafter described.

Finish. 3. (*a*) The wire, in all shapes, must be free from all surface imperfections not consistent with the best commercial practice.

(*b*) Necessary brazes in hard-drawn wire must be made in accordance with best commercial practice, and tests upon a section of wire containing a braze must show at least 95 per cent. of the tensile strength of the unbrazed wire. Elongation tests are not to be made upon test sections including brazes.

Packages. 4. (*a*) Package sizes for round wire and for cable shall be agreed upon in the placing of individual orders; standard packages of grooved trolley wire shall be shipments upon reels holding about 2,500 lbs. each.

(*b*) The wire shall be protected against damage in ordinary handling and shipping.

Specific Gravity 5. For the purpose of calculating weights, cross sections, etc., the specific gravity of copper shall be taken as 8.90.

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Inspection.

6. All testing and inspection shall be made at the place of manufacture. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to enable him to satisfy himself that the material conforms to the requirements of these specifications.

HARD-DRAWN ROUND WIRE.

Dimensions and Permissible Variations.

7. (*a*) Size shall be expressed as the diameter of the wire in decimal fractions of an inch, using not more than three places of decimals; i. e., in mils.

(*b*) Wire is expected to be accurate in diameter; permissible variations from nominal diameter shall be:

For wire 0.100 in. in diameter and larger, one per cent. over or under;

For wire less than 0.100 in. in diameter, one mil over or under.

(*c*) Each coil is to be gauged at three places, one near each end, and one approximately at the middle; the coil may be rejected if, two points being within the accepted limits, the third point is off gauge more than 2 per cent. in the case of wire 0.064 in. in diameter and larger, or more than 3 per cent. in the case of wire less than 0.064 in. in diameter.

8. Wire shall be so drawn that its tensile strength and elongation shall be at least equal to the value stated in Table I. Tensile tests shall be made upon fair samples, and the elongation of wire larger in diameter than 0.204 in. shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks placed upon the wire originally 10 ins. apart. The elongation of wire 0.204 in. in diameter and smaller shall be determined by measurements made between the jaws of the testing machine. The zero length shall be the distance between the jaws when a load equal to ten per cent. of the required ultimate breaking strength shall have been applied, and the final length shall be the distance between the jaws at the time of rupture. The zero length shall be as near 60 ins. as possible. The fracture shall be between the bench marks in the case of wire larger than 0.204 in. in diameter and between the jaws in the case of smaller wire, and not closer than 1 in. to either bench mark or jaw. If upon testing a sample from any coil of wire, the results are found to

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be below the values stated in the table, tests upon two additional samples shall be made, and the average of the three tests shall determine acceptance or rejection of the coil. For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in the table.

TABLE I.

Diameter, ins.	Area, circular mils.	Tensile Strength, lbs. per sq. in.	Elongation in 10 ins., per cent.
0.460	211,600	49,000	3.75
0.410	168,100	51,000	3.25
0.365	133,225	52,800	2.80
0.325	105,625	54,500	2.40
0.289	83,520	56,100	2.17
0.258	66,565	57,600	1.98
0.229	52,440	59,000	1.79
			In 60 ins.
0.204	41,615	60,100	1.24
0.182	33,125	61,200	1.18
0.165	27,225	62,000	1.14
0.162	26,245	62,100	1.14
0.144	20,735	63,000	1.09
0.134	17,956	63,400	1.07
0.128	16,385	63,700	1.06
0.114	12,995	64,300	1.02
0.104	10,815	64,800	1.00
0.102	10,404	64,900	1.00
0.092	8,464	65,400	0.97
0.091	8,281	65,400	0.97
0.081	6,561	65,700	0.95
0.080	6,400	65,700	0.94
0.072	5,184	65,900	0.92
0.065	4,225	66,200	0.91
0.064	4,096	66,200	0.90
0.057	3,249	66,400	0.89
0.051	2,601	66,600	0.87
0.045	2,025	66,800	0.86
0.040	1,600	67,000	0.85

Electric Conductivity.

9. Electric conductivity shall be determined upon fair samples by resistance measurements at a temperature of 20° C. (68° F.).

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The wire shall not exceed the following limits:

For diameters 0.460 in. to 0.325 in., 900.77 lbs. per mile-ohm at 20° C.

For diameters 0.324 in. to 0.040 in., 910.15 lbs. per mile-ohm at 20° C.

GROOVED TROLLEY WIRE.

Sections.

10. Standard sections shall be those known as the "American Standard" grooved trolley wire sections, the shape and dimensions of which are as shown in Fig. 1.

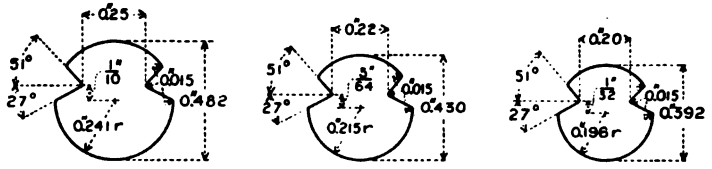


FIG. 1.

Dimensions and Permissible Variations.

11. (*a*) Size shall be expressed as the area of cross section in circular mils, the standard sizes being as follows:

211,600	circular mils,	weighing	3,386	lbs.	per	mile.	
168,100	"	"	"	2,690	"	"	"
133,200	"	"	"	2,132	"	"	"

(*b*) Grooved trolley wire may vary 4 per cent. over or under in weight per unit length from standard, as determined from the nominal cross section.

Physical Tests.

12. The physical tests shall be made in the same manner as those upon round wire. The tensile strength of grooved wire shall be at least 95 per cent. of that required for round wire of the same sectional area; the elongation shall be the same as that required for round wire of the same sectional area.

Electric Conductivity.

13. The requirements for electric conductivity shall be the same as those for round wire of the same sectional area.

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FIGURE-EIGHT TROLLEY WIRE.

14. Standard sections of figure-eight trolley wire shall be as shown in Fig. 2. **Sections.**

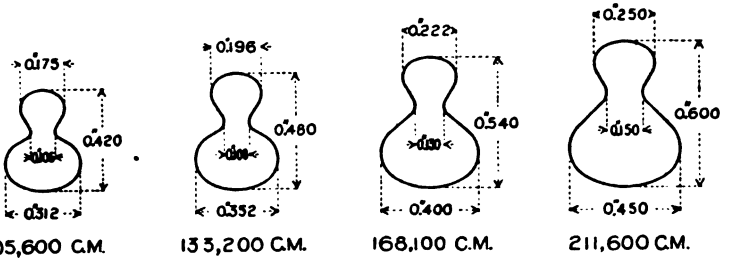


FIG. 2.

15. The requirements for weight, physical properties, and electric conductivity of figure-eight trolley wire shall be the same as for the same sizes of grooved trolley wire. **Requirements.**

HARD-DRAWN COPPER WIRE CABLE OR STRAND.

16. For the purposes of these specifications, standard cable shall be that made up of hard-drawn wire laid concentrically about a hard-drawn wire center. Cable laid up about a hemp center or about a soft wire core is to be subject to special specifications to be agreed upon in individual cases. **Construction.**

17. The wire entering into the construction of stranded cable shall, before stranding, meet all the requirements of round wire, hereinbefore stated. **Wire.**

18. The tensile strength of standard cable shall be at least 90 per cent. of the total strength required of the wires forming the cable. **Physical Tests.**

19. Brazes, made in accordance with the best commercial practice, will be permitted in wire entering into cable; but no two brazes in wire in the cable may be closer together than 50 ft. **Brazes.**

20. The pitch of standard cable shall not be less than 12, nor more than 16, diameters of the cable. The cable shall be laid left-handed or right-handed, as shall be agreed upon in the placing of individual orders. **Lay.**

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EXPLANATORY NOTES ON STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

5. The specific gravity of copper has been commonly accepted as 8.9, and this value is retained in these specifications. The maximum variation from this figure in a large number of samples of wire has not been sufficient to lead one to anticipate any serious error from its use as a flat value in calculations.

7. (*a*) The use of arbitrary gauge numbers to express dimensions cannot be too strongly condemned. There are many such gauges in existence, and confusion is to be expected unless the particular gauge to be used is specified. Many of the gauges have their dimensions stated in absurd figures, such as 0.090742 in., when it is not especially easy to measure dimensions in the fourth decimal place by workshop tools. Definite diameters in measurable units are evidently preferable.

8. Many other physical tests than those provided in these specifications are included in existing specifications. The reasons for the omission of some of the more common are given as follows:

Twist Tests.—The wire is sometimes required to permit twisting through a stated number of revolutions before breaking. The results are so easily influenced by temperature, speed of rotation, method of gripping, and other variables not easily defined or controlled, that the test is at least of doubtful value. It is the opinion of the Committee that it is impractical to so define the conditions of the test that a twist test can be made definite and reliable; hence there is no warrant for its inclusion in specifications.

Wrap Tests.—Wire is sometimes required to permit tight wrapping about a wire of its own diameter, unwrapping and again re-wrapping. It is obvious that the making of a test of this kind with wire that is already hard-drawn is exceedingly difficult. Every one who has tried to break off a piece of tough wire by bending it back and forth between the fingers knows how hard it is to confine the bend to one place, because of the hardening action of the previous bends. Hard wire which has been wrapped around a wire of small diameter is hardened still more and it is almost impossible to straighten the wire, let alone re-coil it in the opposite direction. In the opinion of the Committee, it is inadvisable to include a test

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which at best is so indefinite as a wrap test. Furthermore, it is the opinion of the Committee that wire which will meet the physical tests included in these specifications will meet any properly made twist or wrap test that would reasonably be required.

Since the adoption of the Standard Specifications for Hard-Drawn Copper Wire, proposed in 1909, the Committee has very carefully considered the matter of twist and wrap tests and it is their final opinion that while there might be some possible reason for requiring that wire shall stand wrapping around a wire of equal diameter, there can be no good reason for including in specifications the requirement that it shall stand unwrapping and re-wrapping, because such a test is indefinite and cannot be made otherwise. It is almost physically impossible to unwrap and re-wrap hard-drawn wire about a wire of its own diameter. With respect to twist tests, the Committee has nothing to add to the statement already on record, condemning this character of test.

Elastic Limit.—During the tension test on wire, there is seldom to be observed any definite drop of the beam or increase in the rate of elongation, corresponding to the yield point commonly observed in testing steel. The only way in which the elastic limit of hard wire may be determined is by the actual plotting of the elastic curve from extensometer readings. Even such tests are difficult of interpretation, because the wire when available for tests is usually curved, due to its having been put up in a coil. There are little sets observable before the true elastic limit has been reached, owing to the fact that one side of the wire, having been stretched in coiling, is really a little harder than the other side, and the pull is, therefore, not even. Considering the difficulty of making the test and the uncertainty of the results obtained, it is the opinion of the Committee that it would be inadvisable to include an elastic limit test in these specifications. It is evident that if the designing engineer requires a knowledge of the location of the elastic limit for purposes of calculation in designing, such data can be obtained by special tests on representative sizes of wire, which will fix the relation of the elastic limit to the ultimate strength for all wire which is properly made.

Tests carefully made by members of the Committee show that the elastic limit of hard-drawn copper wire from sizes 0.460 to 0.325 in., inclusive, averages 55 per cent. of the ultimate tensile

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strength required in these specifications, with a minimum value of 50 per cent.; for sizes 0.324 to 0.040 in., inclusive, it averages 60 per cent. of the ultimate tensile strength required in these specifications with a minimum value of 55 per cent. This statement of experience is based on the definition of elastic limit as "that point on the elastic curve beyond which the ratio of stress to strain ceases to be constant."

9. *Conductivity.*—Electric conductivity is usually expressed as a percentage on the Matthiesen basis, reference being made to determinations of the electrical resistivity of supposedly pure copper by Matthiesen, about 1865. Since that time, the methods of refining copper have greatly improved, so that to-day it is not uncommon to find copper of over 100 per cent. conductivity on the Matthiesen basis. Furthermore, what the electrical engineer requires is that the wire shall not exceed a certain maximum electrical resistance. It seems obvious that it is less laborious to express quantities in direct definite terms, rather than by reference to something else which requires interpretation before the results are ready for use in calculation. Resistivity is commonly expressed in a number of different ways, all being equivalent to the resistance of some unit of cross section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions.

For the convenience of those who are accustomed to expressing resistivity or conductivity in any one of several more or less common units, Table II has been prepared giving the conductivity and resistivity of copper at 20° C., expressed in the several common units and covering a range of resistivity that would be covered by copper meeting the terms of the specifications.

10. It is obvious that the simplest designation of irregular shapes of similar outline is by sectional area, and the most commonly used unit among electrical engineers is the circular mil. Therefore, while the sizes of grooved trolley wire regularly used are generally known by B & S gauge number, corresponding to their sectional area, it has been deemed advisable by the Committee to list these sizes, in specifications, by their sectional area expressed in circular mils. The three sizes which are most extensively used commercially are the only ones listed; a fourth size is but little used, and the use is growing less.

11. The only way in which gauge variations are easily

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TABLE II.—CONDUCTIVITY AND RESISTIVITY OF COPPER.

Temperature 20° C. Density taken as 8.90.

Conductivity, per cent.	Ohms per meter-gram.	Lbs. per mile-ohm.	Microhms per cc.	Microhms per cu. in.	Ohms per mil-foot.
102.0	0.15002	856.62	1.6856	0.66363	10.140
101.9	0.15017	857.46	1.6873	0.66428	10.149
101.8	0.15032	858.30	1.6889	0.66404	10.159
101.7	0.15046	859.14	1.6906	0.66559	10.169
101.6	0.15061	859.99	1.6923	0.66625	10.179
101.5	0.15076	860.84	1.6939	0.66690	10.189
101.4	0.15091	861.68	1.6956	0.66756	10.200
101.3	0.15106	862.54	1.6973	0.66822	10.210
101.2	0.15121	863.39	1.6990	0.66888	10.220
101.1	0.15136	864.24	1.7006	0.66954	10.230
101.0	0.15151	865.10	1.7023	0.67020	10.240
100.9	0.15166	865.95	1.7040	0.67087	10.250
100.8	0.15181	866.81	1.7057	0.67153	10.260
100.7	0.15196	867.67	1.7074	0.67220	10.270
100.6	0.15211	868.54	1.7091	0.67287	10.281
100.5	0.15226	869.40	1.7108	0.67354	10.291
100.4	0.15241	870.27	1.7125	0.67421	10.301
100.3	0.15256	871.13	1.7142	0.67488	10.311
100.2	0.15272	872.00	1.7159	0.67555	10.322
100.1	0.15287	872.88	1.7176	0.67623	10.332
100.0	0.15302	873.75	1.7193	0.67691	10.342
99.9	0.15317	874.62	1.7211	0.67758	10.353
99.8	0.15333	875.50	1.7228	0.67826	10.363
99.7	0.15348	876.38	1.7245	0.67894	10.373
99.6	0.15364	877.26	1.7262	0.67962	10.384
99.5	0.15379	878.14	1.7280	0.68031	10.394
99.4	0.15394	879.02	1.7297	0.68099	10.405
99.3	0.15410	879.91	1.7315	0.68168	10.415
99.2	0.15426	880.79	1.7332	0.68236	10.426
99.1	0.15441	881.68	1.7350	0.68305	10.436
99.0	0.15457	882.57	1.7367	0.68374	10.447
98.9	0.15472	883.47	1.7385	0.68443	10.457
98.8	0.15488	884.36	1.7402	0.68513	10.468
98.7	0.15504	885.26	1.7420	0.68582	10.479
98.6	0.15519	886.15	1.7438	0.68652	10.489
98.5	0.15535	887.05	1.7455	0.68721	10.500
98.4	0.15551	887.96	1.7473	0.68791	10.510
98.3	0.15567	888.86	1.7491	0.68861	10.521
98.2	0.15583	889.76	1.7509	0.68931	10.532
98.1	0.15598	890.67	1.7526	0.69002	10.543
98.0	0.15614	891.58	1.7544	0.69072	10.553
97.9	0.15630	892.49	1.7562	0.69142	10.564
97.8	0.15646	893.40	1.7580	0.69213	10.575
97.7	0.15662	894.32	1.7598	0.69284	10.586
97.6	0.15678	895.23	1.7616	0.69355	10.597
97.5	0.15694	896.15	1.7634	0.69426	10.607
97.4	0.15711	897.07	1.7652	0.69497	10.618
97.3	0.15727	897.99	1.7671	0.69569	10.629
97.2	0.15743	898.92	1.7689	0.69640	10.640
97.1	0.15759	899.84	1.7707	0.69712	10.651
97.0	0.15775	900.77	1.7725	0.69784	10.662
96.9	0.15792	901.70	1.7743	0.69856	10.673
96.8	0.15808	902.63	1.7762	0.69928	10.684
96.7	0.15824	903.57	1.7780	0.70001	10.695
96.6	0.15841	904.50	1.7799	0.70073	10.706
96.5	0.15857	905.44	1.7817	0.70146	10.717
96.4	0.15874	906.38	1.7835	0.70218	10.729
96.3	0.15890	907.32	1.7854	0.70291	10.740
96.2	0.15907	908.26	1.7873	0.70364	10.751
96.1	0.15923	909.21	1.7891	0.70438	10.762
96.0	0.15940	910.15	1.7910	0.70511	10.773

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determinable in irregular shapes is by recourse to weights of standard lengths, and this has been the method adopted in the specifications.

16. So many variations in the construction of cable are possible that it has been deemed inadvisable to complicate the specifications by including requirements for any other than the one type most commonly used.

18. Physical testing of cable is at best a difficult matter, and the measurement of elongation in cable which has been subjected to a tensile test is uncertain, since it includes the elastic deformation of the cable as a spring, the actual elongation of the wires, and perhaps even some elastic deformation of the wires as such. It is, therefore, thought inadvisable to include a requirement covering an elongation test.

19. The permitting of brazes in wire entering into the construction of copper cable was discussed at considerable length, and it is finally the opinion of the Committee that, provided no two brazes are closer together than 50 ft., the cable has fully 90 per cent. of the theoretical strength obtained by adding together the required strengths of the constituent wires. This is due, in such long lengths, to the frictional gripping of the wires in the cable. The construction of long lengths of cable without brazes is costly, and it has been thought best, therefore, to permit their use, provided they are sufficiently widely spaced as not to be detrimental to the strength of the cable.

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STANDARD SPECIFICATIONS FOR COPPER-WIRE BARS, CAKES, SLABS, BILLETS, INGOTS, AND INGOT BARS.

ADOPTED AUGUST 21, 1911.

Marks. 1. All wire bars, cakes, slabs, and billets shall be stamped with the maker's brand and furnace charge mark. Ingots and ingot bars shall have a brand stamped or cast in, but need have no furnace charge mark.

Lots. 2. The refiner shall arrange carloads or lots so that as far as possible each shall contain pieces from but one furnace charge, in order to facilitate testing by the user.

Quality. 3. (*a*) *Metal Contents.*—The copper in all shapes shall have a purity of at least 99.880 per cent. as determined by electrolytic assay, silver being counted as copper.

(*b*) *Conductivity.*—All wire bars shall have a conductivity of at least 98.5 per cent. (annealed); all ingots and ingot bars shall have a conductivity of at least 97.5 per cent. (annealed), excepting only arsenical copper, which shall have a conductivity of not less than 90 per cent. (annealed).

Cakes, slabs, and billets shall come under the ingot classification, except when specified for electrical use at time of purchase, in which case wire-bar classification shall apply.

The "Annealed Copper Standard," or resistance of a meter-gram of standard annealed copper at 20° C., shall be considered as 0.15302 international ohm. The per cent. conductivity for the

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purposes of this specification shall be calculated by dividing the resistivity of the Annealed Copper Standard by the resistivity of the sample at 20° C.

Physical Standard.

4. Wire bars, cakes, slabs, and billets shall be substantially free from shrink holes, cold sets, pits, sloppy edges, concave tops and similar defects in set or casting. This clause shall not apply to ingots or ingot bars, in which case physical defects are of no consequence.

Weights of Individual Pieces.

5. Five per cent. variation in weight or ¼ in. variation in any dimension from the refiner's published list or purchaser's specified size shall be considered good delivery; provided, however, that wire bars may vary in length 1 per cent. from the listed or specified length, and cakes 3 per cent. from the listed or specified size in any dimension greater than 8 ins. The weight of ingot and ingot-bar copper shall not exceed that specified by more than 10 per cent., but otherwise its variation is not important.

Claims.

6. Claims must be made in writing within thirty days of receipt of copper at the customer's mill, and the results of the customer's tests shall accompany such claims. The refiner shall be given one week from date of receipt of complaint to investigate his records, and shall then either agree to replace the defective copper or send a representative to the mill. No claims will be considered unless made as above stated, and if the copper in question, unused, cannot be shown to the refiner's representative.

Claims against quality will be considered as follows:

(*a*) Conductivity by furnace charges, ingot lots, or ingot-bar lots.

(*b*) Metal contents by furnace charges, ingot lots, or ingot-bar lots.

(*c*) Physical defects by individual pieces.

(*d*) Variation in weights or dimensions by individual pieces.

Investigation of Claims.

7. The refiner's representative shall inspect all pieces where physical defects or weight or dimension variation is claimed. If agreement is not reached the question of fact shall be submitted to a mutually agreeable umpire, whose decision shall be final.

In a question of metal contents each party shall select a sample of two pieces. These shall be drilled in the presence of both parties, several holes approximately ½ in. in diameter being drilled

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completely through each piece, scale from set to be rejected. No lubricant shall be used and drilling shall not be forced sufficiently to cause oxidation of chips. The resulting samples shall be cut up, mixed, and separated into three parts, each of which shall be placed in a sealed package, one for each party and one for the umpire if necessary. Each party shall make an analysis, and if the results do not establish or dismiss the claim to the satisfaction of both parties the third sample shall be submitted to a mutually agreeable umpire, who shall determine the question of fact, and whose determination shall be final.

In a question of conductivity each party shall select two samples, and in the presence of both parties these shall be rolled hot and drawn cold into wire of 0.080 in. diameter, which shall be annealed at approximately 500° C. Three samples shall be cut from each coil and the same procedure followed as described in the previous paragraph.

Settlement of Claims.

8. The expenses of the shipper's representative and of the umpire shall be paid by the loser, or divided in proportion to the concession made in case of compromise. In case of rejection being established, the damage shall be limited to payment of freight both ways by the refiner for substitution of an equivalent weight of copper meeting these specifications.

EXPLANATORY NOTE.

These specifications are intended to allow for the fact that the refiner produces copper and gauges its quality in furnace charge lots, while the user purchases copper in carload lots, necessarily obtaining a different basis for sampling.

It is intended to cover in these specifications an average grade of copper suitable for all mechanical uses and for making alloys to be used in various wrought forms.

The specifications also recognize the fact that certain shapes are largely put to electrical uses where high electrical conductivity is important.

They do not take into consideration the so-called casting copper used for the purpose of alloying with other metals to produce cast shapes.

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STANDARD SPECIFICATIONS FOR SPELTER.

ADOPTED AUGUST 21, 1911.

1. Under these specifications Virgin Spelter, that is, spelter made from ore or similar raw material by a process of reduction and distillation and not produced from re-worked metal, is considered in four grades, as follows:

A.....High Grade.
B.....Intermediate.
C.....Brass Special.
D.....Prime Western.

Marks. 2. A brand shall be cast in each slab by which the maker and grade can be identified.

Lots. 3. The maker shall use care to have each carload of as uniform quality as possible.

Composition. 4. *A. High Grade.*—The spelter shall not contain over

0.07 per cent. lead.
0.03 " " iron.
0.05 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 0.10 per cent.

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B. Intermediate.—The spelter shall not contain over

0.20 per cent. lead.
0.03 " " iron.
0.50 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 0.50 per cent.

C. Brass Special.—The spelter shall not contain over

0.75 per cent. lead.
0.04 " " iron.
0.75 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 1.20 per cent.

D. Prime Western.—The spelter shall not contain over

1.50 per cent. lead.
0.08 " " iron.

5. The slabs shall be reasonably free from surface corrosion or adhering foreign matter. **Physical.**

6. Not less than ten slabs shall be taken as a sample from each car; for smaller lots, in the same proportion to the total number, but in no case less than three slabs. In case of dispute half of the sample is to be taken by the maker and half by the purchaser; and the whole shall be mixed. **Sampling.**

The slabs selected as samples are to be sawed completely across and the sawdust used as a sample. In case no saw is available for this purpose, the slabs should be drilled completely through and the drillings cut up into short lengths. The saw or drill used must be thoroughly cleaned. No lubricant shall be used in either sawing or drilling, and the sawdust or drilling must be carefully treated with a magnet to remove any particles of iron derived from the tools.

7. *Lead.*—For the determination of lead in High Grade not less than 25 grams, in Intermediate not less than 15, in Brass Special not less than 10, and in Prime Western not less than 5 grams, shall be taken; that is, the sample used for analysis should not contain less than 0.01 gram lead. **Analysis.**

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Iron.—The sample for iron should contain not less than 25 grams for the three higher grades and not less than 10 grams for Prime Western. The entire sample must be dissolved, the iron precipitated as ferric-hydroxide, then re-dissolved, reduced, and the iron determined by titration.

Cadmium.—Dissolve 25 grams in 330 cc. of a solution of one part of hydrochloric acid (specific gravity 1.2) and five parts of water. Let it stand over night; filter and wash; reject filtrate and dissolve the residue, which should be about 5 per cent. of the zinc, in nitric acid. Add 10 cc. of sulphuric acid; evaporate to fumes; dilute and filter out and wash the lead sulphate. Dilute the solution to 500 cc.; add 5 grams of ammonium chloride; pass a slow stream of hydrogen sulphide for one hour and let stand for about five hours; filter, wash with hot water; dissolve in 10 cc. of sulphuric acid and 50 cc. of water; filter and wash. Dilute to 400 cc.; precipitate with hydrogen sulphide as before. Weigh as cadmium sulphide or dissolve in hydrochloric acid and titrate with potassium ferrocyanide.

Claims. 8. Claims to be considered shall be in writing within thirty days of receipt of material at customer's mill and the results of customer's test shall be given. The shipper shall be given one week from date of receipt of such claim to investigate his records and then shall either agree to satisfy the claim or send a representative to the mill.

(*a*) *Analysis by Car Lots.*—No claims shall be considered unless the minimum samples as specified for the grade in question can be shown to such representative.

(*b*) *Physical Defects of Individual Pieces.*—No claims shall be considered unless the spelter in question, unused, can be shown to such representative.

Mill Treatment. 9. Where the spelter satisfies the chemical and physical requirements of these specifications, it shall not be condemned for defects of alloys in which it is used or for defects in the coating of galvanized products.

Investigation of Claims. 10. The maker's representative shall inspect all pieces where physical defects are claimed. If agreement is not reached the question of fact shall be submitted to a mutually agreeable umpire, whose decision shall be final.

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On a question of metal contents an adequate sample shall be drawn by the representatives of both parties; the sample shall be prepared from the slabs so selected as described under "Sampling." The sample shall be mixed and separated into three parts, each of which shall be placed in a sealed package, one for each party and one for the umpire if necessary. Each party shall make an analysis and if the results do not establish or dismiss the claim to the satisfaction of both parties, the third sample shall be submitted to a mutually agreeable umpire, who shall determine the question of quality and whose determination shall be final.

Settlement of Claims.

11. The expenses of the maker's representative and of the umpire shall be paid by the loser or divided in proportion to concession made in case of compromise.

In case of rejection being established, damages shall be limited to the payment of freight both ways by the maker for substitution of an equivalent weight of spelter meeting these specifications.

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STANDARD SPECIFICATIONS FOR MANGANESE BRONZE INGOTS.

ADOPTED AUGUST 21, 1911.

General. 1. This specification is intended to cover manganese-bronze ingots, having notched flat bottoms, approximately 3 by $2\frac{3}{4}$ ins. wide by 12 ins. long, properly tapered to strip easily from an iron mold.

Chemical Composition. 2. The chemical composition shall be as follows:

Copper	55	to 60	per cent.
Zinc	39	to 45	" "
Iron	not over	2	" "
Tin	not over	2	" "
Aluminum	not over	0.5	" "
Manganese	not over	0.5	" "

Physical Properties. 3. The ultimate tensile strength shall be not less than 70,000 lbs. per sq. in.

The elongation in 2 ins. shall be not less than 20 per cent.

Test Specimens. 4. The standard turned test specimen, as shown by Fig. 1, 0.5 in. diameter and 2 ins. gauge length, shall be used to determine the physical properties as specified above.

Number and Location of Test of Specimens. 5. One test ingot shall be selected by the inspector to represent 10,000 lbs. of ingots or fraction thereof. The test specimen shall be cut from one corner near the bottom of the ingot. In case the test specimen shows a flaw, two additional tests may be selected by the inspector from the same lot, and tested to represent the lot in question.

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6. Each furnace charge shall be kept separate until the lot is sampled by the inspector, and each ingot thereof stamped with its proper heat number. When the ingot is sampled at destination, various heats can be mixed in shipment, but must be stamped with their proper heat number. **Marking.**

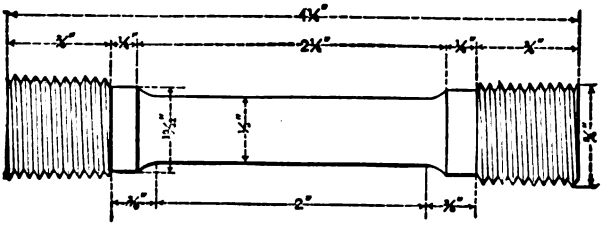


FIG. 1.

7. All ingots in each lot will be rejected upon the physical tests or chemical composition, irrespective of the heat or heats from which the test ingots are selected. **Rejections.**

8. In case the buyer's tests show that the material does not meet these specifications, the seller shall have an opportunity to inspect the material and each party shall select a sample for re-test. If the results do not agree, each shall select a sample to be sent to a mutually agreeable umpire, whose decision shall be final. The costs of such re-tests shall be paid by the loser. **Investigation of Claims.**

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STANDARD SPECIFICATIONS FOR CEMENT.

ADOPTED AUGUST 16, 1909.

GENERAL OBSERVATIONS.

1. These remarks have been prepared with a view of pointing out the pertinent features of the various requirements and the precautions to be observed in the interpretation of the results of the tests.

2. The Committee would suggest that the acceptance or rejection under these specifications be based on tests made by an experienced person having the proper means for making the tests.

SPECIFIC GRAVITY.

3. Specific gravity is useful in detecting adulteration. The results of tests of specific gravity are not necessarily conclusive as an indication of the quality of a cement, but when in combination with the results of other tests may afford valuable indications.

FINENESS.

4. The sieves should be kept thoroughly dry.

TIME OF SETTING.

5. Great care should be exercised to maintain the test pieces under as uniform conditions as possible. A sudden change or wide range of temperature in the room in which the tests are made, a very dry or humid atmosphere, and other irregularities vitally affect the rate of setting.

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CONSTANCY OF VOLUME.

6. The tests for constancy of volume are divided into two classes, the first normal, the second accelerated. The latter should be regarded as a precautionary test only, and not infallible. So many conditions enter into the making and interpreting of it that it should be used with extreme care.

7. In making the pats the greatest care should be exercised to avoid initial strains due to molding or to too rapid drying-out during the first twenty-four hours. The pats should be preserved under the most uniform conditions possible, and rapid changes of temperature should be avoided.

8. The failure to meet the requirements of the accelerated tests need not be sufficient cause for rejection. The cement may, however, be held for twenty-eight days, and a retest made at the end of that period, using a new sample. Failure to meet the requirements at this time should be considered sufficient cause for rejection, although in the present state of our knowledge it cannot be said that such failure necessarily indicates unsoundness, nor can the cement be considered entirely satisfactory simply because it passes the tests.

SPECIFICATIONS.

GENERAL CONDITIONS.

1. All cement shall be inspected.

2. Cement may be inspected either at the place of manufacture or on the work.

3. In order to allow ample time for inspecting and testing, the cement should be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

4. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

5. Every facility shall be provided by the Contractor and a period of at least twelve days allowed for the inspection and necessary tests.

6. Cement shall be delivered in suitable packages with the brand and name of manufacturer plainly marked thereon.

7. A bag of cement shall contain 94 pounds of cement net. Each barrel of Portland cement shall contain 4 bags, and each barrel of natural cement shall contain 3 bags of the above net weight.

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8. Cement failing to meet the seven-day requirements may be held awaiting the results of the twenty-eight-day tests before rejection.

9. All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, and January 15, 1908, with all subsequent amendments thereto. (See addendum to these specifications.)

10. The acceptance or rejection shall be based on the following requirements:

NATURAL CEMENT.

11. *Definition.* This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

FINENESS.

12. It shall leave by weight a residue of not more than 10 per cent. on the No. 100, and 30 per cent. on the No. 200 sieve.

TIME OF SETTING.

13. It shall not develop initial set in less than ten minutes; and shall not develop hard set in less than thirty minutes, or in more than three hours.

TENSILE STRENGTH.

14. The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Age.	*Neat Cement.*	*Strength.*
24 hours in moist air		75 lbs.
7 days (1 day in moist air, 6 days in water)		150 "
28 days (1 " " " 27 " ")		250 "
	One Part Cement, Three Parts Standard Ottawa Sand.	
7 days (1 day in moist air, 6 days in water)		50 lbs.
28 days (1 " " " 27 " ")		125 "

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CONSTANCY OF VOLUME.

15. Pats of neat cement about three inches in diameter, one-half inch thick at center, tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(*a*) A pat is then kept in air at normal temperature.

(*b*) Another is kept in water maintained as near 70° F. as practicable.

16. These pats are observed at intervals for at least 28 days, and, to satisfactorily pass the tests, shall remain firm and hard and show no signs of distortion, checking, cracking, or disintegrating.

PORTLAND CEMENT.

17. *Definition.* This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent. has been made subsequent to calcination.

SPECIFIC GRAVITY.

18. The specific gravity of cement shall not be less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

FINENESS.

19. It shall leave by weight a residue of not more than 8 per cent. on the No. 100, and not more than 25 per cent. on the No. 200 sieve.

TIME OF SETTING.

20. It shall not develop initial set in less than thirty minutes; and must develop hard set in not less than one hour, nor more than ten hours.

TENSILE STRENGTH.

21. The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and

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the cement shall show no retrogression in strength within the periods specified:

Age.	*Neat Cement.*	*Strength.*
24 hours	in moist air	175 lbs.
7 days	(1 day in moist air, 6 days in water)	500 "
28 days	(1 " " " 27 " ")	600 "

One Part Cement, Three Parts Standard Ottawa Sand.		
7 days	(1 day in moist air, 6 days in water)	200 lbs.
28 days	(1 " " " 27 " ")	275 "

CONSTANCY OF VOLUME.

22. Pats of neat cement about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(*a*) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(*b*) Another pat is kept in water maintained as near 70° F. as practicable, and observed at intervals for at least 28 days.

(*c*) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

23. These pats, to satisfactorily pass the requirements, shall remain firm and hard, and show no signs of distortion, checking, cracking, or disintegrating.

SULPHURIC ACID AND MAGNESIA.

24. The cement shall not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3), nor more than 4 per cent. of magnesia (MgO).

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ADDENDUM.

ABSTRACT OF METHODS RECOMMENDED BY THE SPECIAL COMMITTEE ON UNIFORM TESTS OF CEMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SAMPLING.

2.—*Selection of Sample.*—The sample shall be a fair average of the contents of the package; it is recommended that, where conditions permit, one barrel in every ten be sampled.

3.—Samples should be passed through a sieve having twenty meshes per linear inch, in order to break up lumps and remove foreign material; this is also a very effective method for mixing them together in order to obtain an average. For determining the characteristics of a shipment of cement, the individual samples may be mixed and the average tested; where time will permit, however, it is recommended that they be tested separately.

4.—*Method of Sampling.*—Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or a sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center

CHEMICAL ANALYSIS.

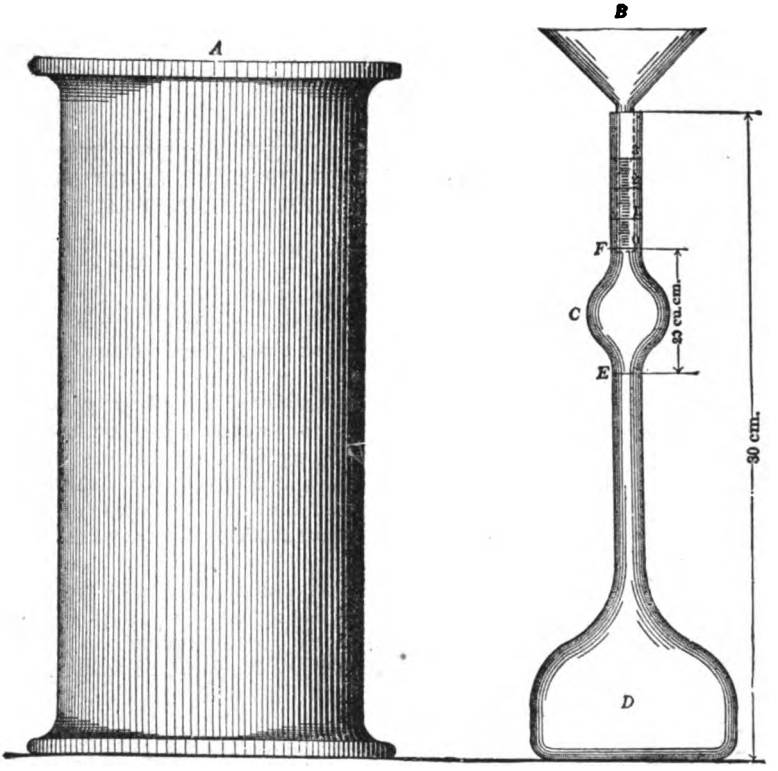
7.—*Method.*—As a method to be followed for the analysis of cement, that proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, of the New York Section of the Society for Chemical Industry, and published in the *Engineering News*, Vol. 50, p. 60, 1903, and in the *Engineering Record*, Vol. 48, p. 49, 1903, is recommended. (See Appendix.)

SPECIFIC GRAVITY.

10.—*Apparatus and Method.*—The determination of specific gravity is most conveniently made with Le Chatelier's apparatus. This consists of a flask (*D*), Fig. 1, of 120 cc. (7.32 cu. ins.) capacity, the neck of which is about 20 cm. (7.87 ins.) long; in the middle of this neck is a bulb (*C*), above and below which are two marks (*F*) and (*E*); the volume between these marks is 20 cc. (1.22 cu. ins.). The neck has a diameter of about 9 mm. (0.35 in.), and is graduated into tenths of cubic centimeters above the mark (*F*).

11.—Benzine (62° Baumé naphtha), or kerosene free from water should be used in making the determination.

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LE CHATELIER'S SPECIFIC GRAVITY APPARATUS
FIG. 1.

12.—The specific gravity is determined as follows:

The flask is filled with either of these liquids to the lower mark (*E*), and 64 gr. (2.25 oz.) of powder, cooled to the temperature of the liquid, is gradually introduced through the funnel (*B*) [the stem of which extends into the flask to the top of the bulb (*C*)], until all of the powder is introduced, and the level of the liquid rises to some division of the graduated neck. This reading plus 20 cc. is the volume displaced by 64 gr. of the powder.

13.—The specific gravity is then obtained from the formula:

$$\text{Specific Gravity} = \frac{\text{Weight of Cement, in grams.}}{\text{Displaced Volume, in cubic centimeters.}}$$

14.—The flask, during the operation, is kept immersed in water in a jar (*A*), in order to avoid variations in the temperature of the liquid.

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The results should agree within 0.01. The determination of specific gravity should be made on the cement as received; and, should it fall below 3.10, a second determination should be made on the sample ignited at a low red heat.

15.—A convenient method for cleaning the apparatus is as follows: The flask is inverted over a large vessel, preferably a glass jar, and shaken vertically until the liquid starts to flow freely; it is then held still in a vertical position until empty; the remaining traces of cement can be removed in a similar manner by pouring into the flask a small quantity of clean liquid (benzine or kerosene) and repeating the operation.

FINENESS.

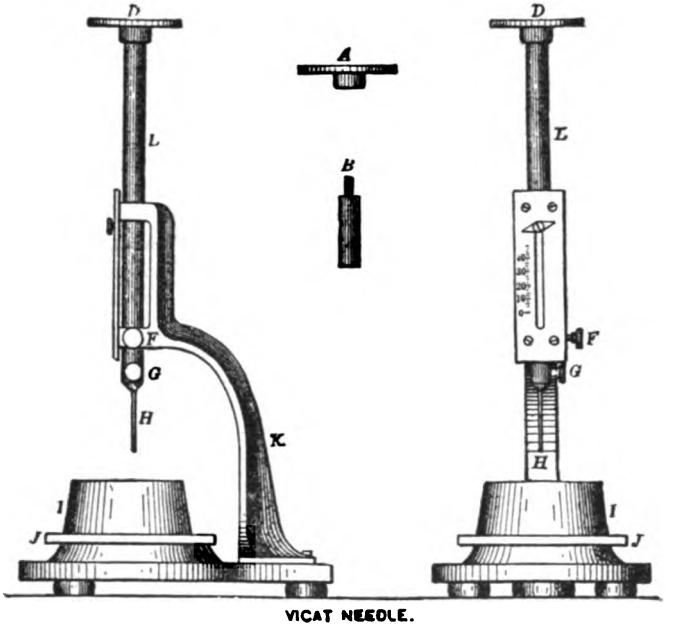
18.—*Apparatus.*—The sieves should be circular, about 20 cm. (7.87 ins.) in diameter, 6 cm. (2.36 ins.) high, and provided with a pan, 5 cm. (1.97 ins.) deep, and a cover.

19.—The wire cloth should be of brass wire having the following diameters:

No. 100, 0.0045 in.; No. 200, 0.0024 in.

20.—This cloth should be mounted on the frames without distortion: the mesh should be regular in spacing and be within the following limits

No. 100, 96 to 100 meshes to the linear inch.
No. 200, 188 to 200 " " " "



VICAT NEEDLE.
FIG. 2.

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21.—Fifty grams (1.76 oz.) or 100 gr. (3.25 oz.) should be used for the test, and dried at a temperature of 100° C. (212° F.) prior to sieving.

22.—*Method.*—The thoroughly dried and coarsely screened sample is weighed and placed on the No. 200 sieve, which, with pan and cover attached, is held in one hand in a slightly inclined position, and moved forward and backward, at the same time striking the side gently with the palm of the other hand, at the rate of about 200 strokes per minute. The operation is continued until not more than one-tenth of one per cent. passes through after one minute of continuous sieving. The residue is weighed, then placed on the No. 100 sieve and the operation repeated. The work may be expedited by placing in the sieve a small quantity of steel shot. The results should be reported to the nearest tenth of one per cent.

NORMAL CONSISTENCY.

26. *Method.*—This can best be determined by means of *Vicat Needle Apparatus*, which consists of a frame (*K*), Fig. 2, bearing a movable rod (*L*), with the cap (*A*) at one end, and at the other the cylinder (*B*), 1 cm. (0.39 in.) in diameter, the cap, rod and cylinder weighing 300 gr. (10.58 oz.). The rod, which can be held in any desired position by a screw (*F*), carries an indicator, which moves over a scale (graduated to centimeters) attached to the frame (*K*). The paste is held by a conical, hard-rubber ring (*I*), 7 cm. (2.76 ins.) in diameter at the base, 4 cm. (1.57 ins.) high, resting on a glass plate (*J*), about 10 cm. (3.94 ins.) square.

27.—In making the determination, the same quantity of cement as will be subsequently used for each batch in making the briquettes (but not less than 500 grams) is kneaded into a paste, as described in Paragraph 52, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained 6 ins. apart; the ball is then pressed into the rubber ring, through the larger opening, smoothed off and placed (on its large end) on a glass plate and the smaller end smoothed off with a trowel; the paste, confined in the ring, resting on the plate, is placed under the rod bearing the cylinder, which is brought in contact with the surface and quickly released.

28.—The paste is of normal consistency when the cylinder in one minute from the time it is released penetrates to a point in the mass 10 mm. (0.39 in.) below the top of the ring. Great care must be taken to fill the ring exactly to the top. The apparatus must be free from all vibrations during the test.

29.—The trial pastes are made with varying percentages of water until the correct consistency is obtained.

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31.—Having determined in this manner the proper percentage of water required to produce a paste of normal consistency, the proper percentage required for mortars is obtained from the table below.

PERCENTAGE OF WATER FOR STANDARD SAND MORTARS.

Neat.	One Cement, Three Standard Ottawa Sand.	Neat.	One Cement, Three Standard Ottawa Sand.	Neat.	One Cement, Three Standard Ottawa Sand.
15.....	8.0	23.....	9.3	31.....	10.7
16.....	8.2	24.....	9.5	32.....	10.8
17.....	8.3	25.....	9.7	33.....	11.0
18.....	8.5	26.....	9.8	34.....	11.2
19.....	8.7	27.....	10.0	35.....	11.5
20.....	8.8	28.....	10.2	36.....	11.5
21.....	9.0	29.....	10.3	37.....	11.7
22.....	9.2	30.....	10.5	38.....	11.8

TIME OF SETTING.

34.—*Method.*—For this purpose the Vicat Needle, which has already been described in Paragraph 26, should be used.

35.—In making the test, a paste of normal consistency is molded and placed under the rod (*L*), Fig. 2, as described in Paragraph 27; this rod, bearing the cap (*D*) at one end and the needle (*H*), 1 mm. (0.039 in.) in diameter, at the other, weighing 300 gr. (10.58 oz.). The needle is then carefully brought in contact with the surface of the paste and quickly released.

36.—The setting is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 in.) above the upper surface of the glass plate, and is said to have terminated the moment the needle does not sink visibly into the mass.

37.—The test pieces should be stored in moist air during the test; this is accomplished by placing them on a rack over water contained in a pan and covered with a damp cloth, the cloth to be kept away from them by means of a wire screen; or they may be stored in a moist box or closet.

38.—Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point reduces the area and tends to increase the penetration.

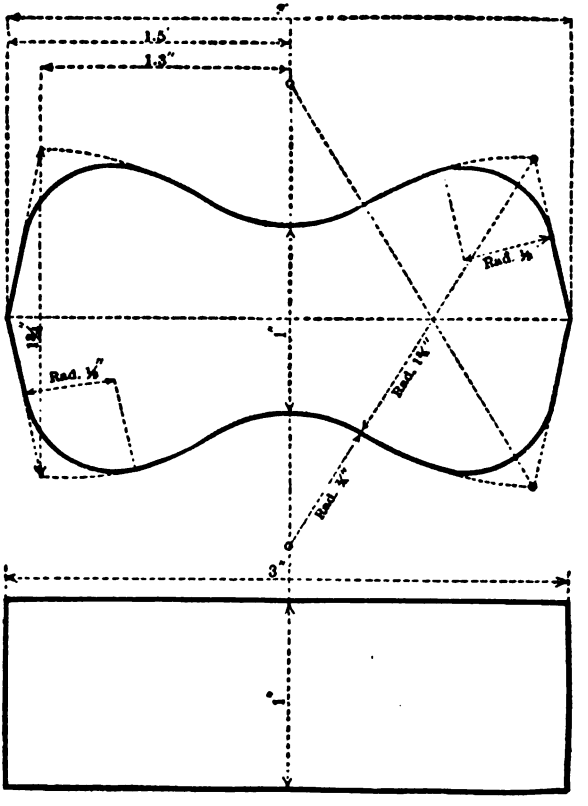
39.—The determination of the time of setting is only approximate, being materially affected by the temperature of the mixing water, the temperature and humidity of the air during the test, the percentage of water used, and the amount of kneading the paste receives.

STANDARD SAND.

40.—The Committee recommends the natural sand from Ottawa, Ill., screened to pass a sieve having 20 meshes per linear inch and retained on a sieve having 30 meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112 in., respectively, i. e., half the width of the opening in

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each case. Sand having passed the No. 20 sieve shall be considered standard when not more than 1 per cent. passes a No. 30 sieve after one minute continuous sifting of a 500-gram sample.*



DETAILS FOR BRIQUETTE.
FIG. 3.

FORM OF TEST PIECES.

41.—For tension tests the Committee recommends the form of test piece shown in Fig. 3.

42.—For compression tests a two-inch cube is recommended.

MOLDS.

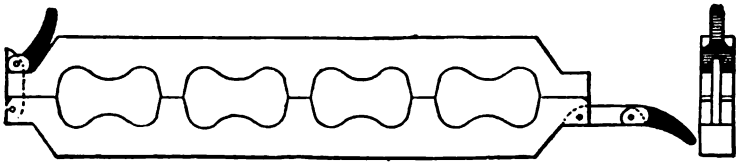
43.—The molds should be made of brass, bronze or some equally non-corrodible material, having sufficient metal in the sides to prevent spreading during molding.

* This sand may be obtained from the Ottawa Silica Company at a cost of two cents per pound f.o.b. cars, Ottawa, Ill.

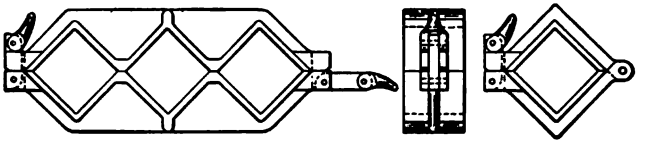
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44.—Gang molds, which permit molding a number of briquettes at one time, are preferred by many to single molds; since the greater quantity of mortar that can be mixed tends to produce greater uniformity in the results. The type shown in Fig. 4 is recommended.

45.—The molds should be wiped with an oily cloth before using.



DETAILS FOR GANG MOLD.
FIG. 4.



MOLD FOR COMPRESSION TEST PIECES
FIG 5

MIXING.

46.—All proportions should be stated by weight; the quantity of water to be used should be stated as a percentage of the dry material.

47.—The metric system is recommended because of the convenient relation of the gram and the cubic centimeter.

48.—The temperature of the room and the mixing water should be as near 21° C. (70° F.) as it is practicable to maintain it.

49.—The sand and cement should be thoroughly mixed dry. The mixing should be done on some non-absorbing surface, preferably plate glass. If the mixing must be done on an absorbing surface it should be thoroughly dampened prior to use.

50.—The quantity of material to be mixed at one time depends on the number of test pieces to be made; about 1,000 gr. (35.28 oz.) makes a convenient quantity to mix, especially by hand methods.

52.—*Method.*—The material is weighed and placed on the mixing table, and a crater formed in the center, into which the proper percentage of clean water is poured; the material on the outer edge is turned into the crater by the aid of a trowel. As soon as the water has been absorbed, which should not require more than one minute, the operation is completed by vigorously kneading with the hands for an additional one minute, the process being similar to that used in kneading dough. A sand-glass affords a convenient guide for the time of kneading. During the operation of mixing, the hands should be protected by gloves, preferably of rubber.

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MOLDING.

53.—Having worked the paste or mortar to the proper consistency, it is at once placed in the molds by hand.

55.—*Method.*—The molds should be filled immediately after the mixing is completed, the material pressed in firmly with the fingers, and smoothed off with a trowel, without mechanical ramming; the material should be heaped up on the upper surface of the mold, and, in smoothing off, the trowel should be drawn over the mold in such a manner as to exert a moderate pressure on the excess material. The mold should be turned over and the operation repeated.

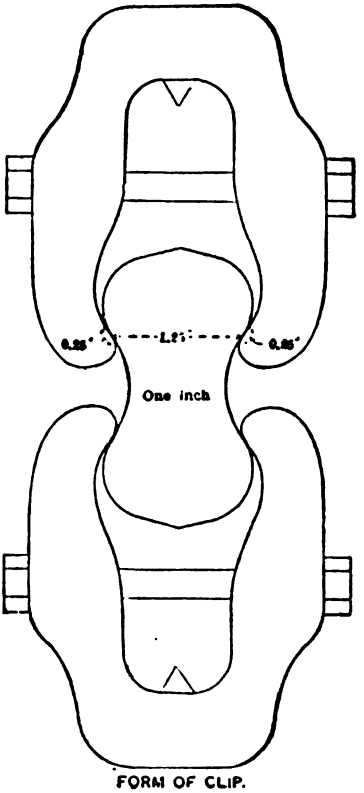
56.—A check upon the uniformity of the mixing and molding is afforded by weighing the briquettes just prior to immersion, or upon removal from the moist closet. Briquettes which vary in weight more than 3 per cent. from the average should not be tested.

STORAGE OF THE TEST PIECES.

57.—During the first 24 hours after molding, the test pieces should be kept in moist air to prevent them from drying out.

58.—A moist closet or chamber is so easily devised that the use of the damp cloth should be abandoned if possible. Covering the test pieces with a damp cloth is objectionable, as commonly used, because the cloth may dry out unequally, and in consequence the test pieces are not all maintained under the same condition. Where a moist closet is not available, a cloth may be used and kept uniformly wet by immersing the ends in water. It should be kept from direct contact with the test pieces by means of a wire screen or some similar arrangement.

59.—A moist closet consists of a soapstone or slate box, or a metal-lined wooden box—the metal lining being covered with felt and this felt kept wet. The bottom of the box is so constructed as to hold water, and the sides are provided with cleats for holding glass shelves on which to place the briquettes. Care should be taken to keep the air in the closet uniformly moist.



FORM OF CLIP.

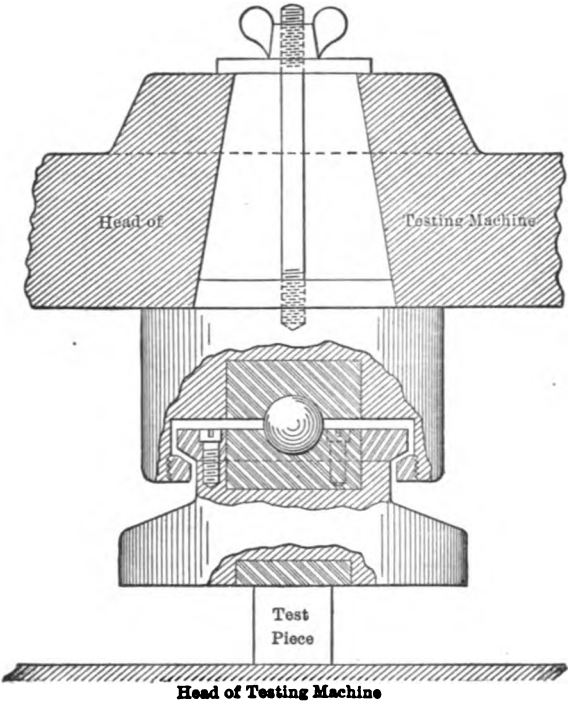
FIG 6.

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60.—After 24 hours in moist air, the test pieces for longer periods of time should be immersed in water maintained as near 21° C. (70°F.) as practicable; they may be stored in tanks or pans, which should be of non-corrodible material.

TENSILE STRENGTH.

61.—The tests may be made on any standard machine. A solid metal clip, as shown in Fig. 6, is recommended. This clip is to be used



BALL-BEARING BLOCK FOR TESTING MACHINE
FIG. 7

without cushioning at the points of contact with the test piece. The bearing at each point of contact should be ½ in. wide, and the distance between the center of contact on the same clip should be 1½ ins.

62.—Test pieces should be broken as soon as they are removed from the water. Care should be observed in centering the briquettes in the testing machine, as cross-strains, produced by improper centering, tend to lower the breaking strength. The load should not be applied too suddenly, as it may produce vibration, the shock from which often breaks

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APPARATUS FOR MAKING ACCELERATED TEST FOR SOUNDNESS OF CEMENT.

To be made of sheet copper weighing 22 oz. per sq. ft., tinned inside.
All seams to be lapped where possible Hard solder only to be used.

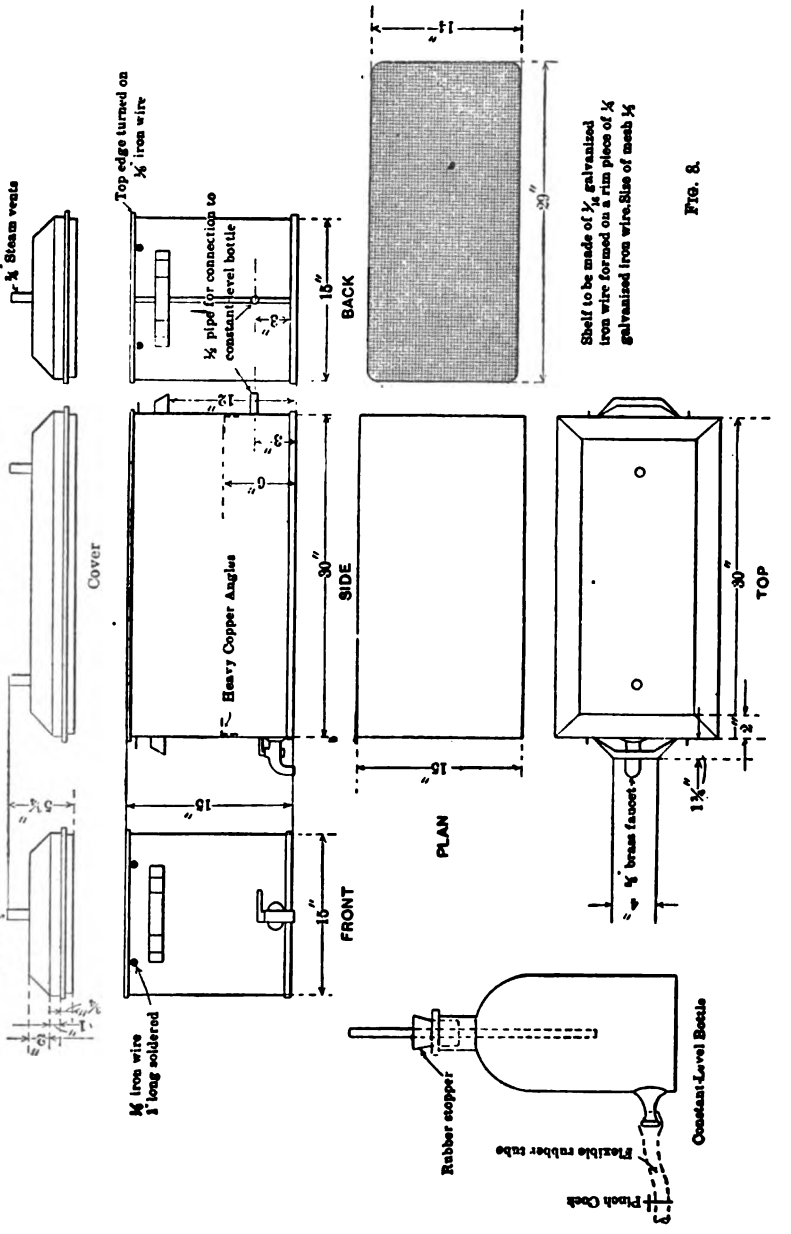


FIG. 8.

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the briquette before the ultimate strength is reached. Care must be taken that the clips and the sides of the briquette be clean and free from grains of sand or dirt, which would prevent a good bearing. The load should be applied at the rate of 600 lbs. per minute. The average of the briquettes of each sample tested should be taken as the test, excluding any results which are manifestly faulty.

COMPRESSIVE STRENGTH.

63.—The tests may be made in any machine provided with a means for so applying the load that the line of pressure is along the axis of the test piece. A ball bearing block for this purpose is shown in Fig. 7.

Some appliance to facilitate placing the center of the ball bearing exactly in the line of the axis of the test piece should be provided.

64.—The test piece should be placed in the testing machine with a piece of heavy blotting paper on each of the crushing surfaces, which should be those that were in contact with the mold.

The test pieces should be broken as soon as they are removed from the water.

CONSTANCY OF VOLUME.

66.—*Methods.*—Tests for constancy of volume are divided into two classes: (1) normal tests, or those made in either air or water maintained at about 21° C. (70° F.), and (2) accelerated tests, or those made in air, steam or water at a temperature of 45° C. (115° F.) and upward. The test pieces should be allowed to remain 24 hours in moist air before immersion in water or steam, or preservation in air.

67.—For these tests, pats about 7½ cm. (2.95 ins.) in diameter, 1½ cm. (0.49 in.) thick at the center, and tapering to a thin edge, should be made, upon a clean glass plate [about 10 cm. (3.94 ins.) square], from cement paste of normal consistency.

68.—*Normal Test.*—A pat is immersed in water maintained as near 21° C. (70° F.) as possible for 28 days, and observed at intervals. A similar pat, after 24 hours in moist air, is maintained in air at ordinary temperature and observed at intervals.

69.—*Accelerated Test.*—A pat is placed in an atmosphere of steam upon a wire screen one inch above boiling water for five hours. The apparatus should be so constructed as to permit the free escape of steam and maintain atmospheric pressure. Since the type of apparatus used has a great influence upon the uniformity of the results, that shown in Fig. 8 is recommended.

70.—To pass these tests satisfactorily, the pats should remain firm and hard, and show no signs of cracking, distortion or disintegration.

71.—Should the pat leave the plate, distortion may be detected best with a straight-edge applied to the surface which was in contact with the plate.

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AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD TEST FOR FIREPROOF FLOOR CONSTRUCTION.

ADOPTED AUGUST 15, 1908.

The test structure may be located at any place convenient to the applicant, where all the necessary facilities for properly conducting the test are provided.

The test structure may be constructed of walls of any material not less than twelve inches thick, properly buttressed on all sides.

The floor construction to be tested shall form the roof of the test structure.

At a height of not less than 2 ft. 6 ins., nor more than 3 ft. above the ground level, a metal grate, properly supported, shall be provided, covering the whole inside area of the building.

In the walls below this grate level, draught openings shall be provided, as many as possible, furnishing openings with an aggregate area of not less than one square foot for every ten square feet of grate surface. Means for temporarily closing these openings should be provided.

In the wall, immediately above the grate level, a firing door, 3 ft. 6 ins. by 5 ft. high, must be provided in the side of the building at right angles to the floor beams. A second door must be added when the span of the floor slab under test exceeds ten feet.

Flues should be supplied at each of the corners, and oftener in case of a test structure exceeding 250 sq. ft. of grate surface, with sufficient opening to insure a proper draught, securely supported and disposed at the sides of the structure in such

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manner as not to rest on the floor under test. In no case should a flue area be less than 180 sq. ins.

The horizontal dimensions of the test structure will depend upon the number and the span of the systems under consideration. The clear span of the floor beams is to be 14 ft. The distance between floor beams, or span of slab, may be varied according to the design of the system to be tested, and should be as near as possible to usual practice. The underside of the construction under test must be not less than 9 ft. 6 ins. nor more than 10 ft. above the grate level.

The construction to be tested should be designed for a working load of 150 lbs. per sq. ft., and no more. This load is to be uniformly distributed without arching effect, and is to be carried on the floor during the fire test.

The floor may be tested as soon after construction as desired, but within forty days. Artificial drying will be allowed if desired.

No plastering shall be applied to the underside of the floor construction under test.

The floor shall be subjected for four hours to the continuous heat of a fire of an average temperature of not less than 1700° F.; the fuel used being either wood or gas, so introduced as to cause an even distribution of heat throughout the test structure.

The heat obtained shall be measured by means of standard pyrometers, under the direction of an experienced person. The type of pyrometer is immaterial so long as its accuracy is secured by proper standardization. The heat should be measured at not less than two points when the main floor span is not more than 10 ft. and one additional point when it exceeds 10 ft. Temperature readings at each point are to be taken every three minutes. The heat determination shall be made at points directly beneath the floor so as to secure a fair average.

At the end of the heat test a stream of water shall be directed against the underside of the floor, discharged through a $1\frac{1}{8}$-in. nozzle, under 60 lbs. nozzle pressure, for ten minutes, the nozzle being held not more than 3 ft. from the firing door during the application of the water.

After the floor has sufficiently cooled the load on the same

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shall be increased to 600 lbs. per sq. ft., uniformly distributed.

The test shall not be regarded as successful unless the following conditions are met: No fire or smoke shall pass through the floor during the fire test; the floor must safely sustain the loads prescribed; the permanent deflection must not exceed one-eighth inch for each foot of span in either slab or beam.

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AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
AFFILIATED WITH THE
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STANDARD TEST FOR FIREPROOF PARTITION CONSTRUCTION.

ADOPTED AUGUST 16, 1909.

The test structure may be located at any place convenient to the investigator, where all the necessary facilities for properly conducting the test are provided.

The test structure shall be of such design that the partition construction to be tested shall form at least one side of the structure. The other sides, roof, and foundations of the structure may be of any materials and design that will withstand and confine the fire within the test structure for the required time.

At a height of not less than 2 ft. 6 ins., nor more than 3 ft., above the ground level, a metal grate, properly supported, shall be provided, covering the whole inside area of the building.

In the walls below the grate level, draught openings shall be provided, as many as possible, furnishing openings with an aggregate area of not less than one square foot for every ten square feet of grate surface. Means for temporarily closing these openings shall be provided.

Immediately above the grate level, in one of the end walls of the structure, a firing door 3 ft. 6 ins. wide by 5 ft. high must be provided.

Flues shall be supplied at each of the corners, and more often for a test structure with more than 250 sq. ft. of grate surface, with sufficient opening to insure a proper draught. In no case shall a flue area be less than 180 sq. ins.

The size of the test structure will depend on the area of the

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partition construction to be tested. In no case shall the partition construction under test be less than 9 ft. 6 ins. high, nor less than 14 ft. 6 ins. long. This entire area must be above the level of the grate bars, and, within such dimensions, must not be reinforced or braced in any manner other than is done as an inherent and essential part of the system of construction. The edges may be supported in any manner fairly representing the conditions of support in good practice.

The width of the test structure at right angles to the partition under test shall not be less than 9 ft.

The construction to be tested shall be subjected for two hours to the continuous heat of a fire, rising in temperature to 1700° F. by the end of the first half hour, and maintained at an average temperature of 1700° F. for the balance of the test; the fuel used being either wood, gas or oil, so introduced as to cause an even distribution of the heat throughout the test structure.

The temperature obtained shall be measured by means of standard pyrometers under the direction of an experienced person. The type of pyrometer is immaterial so long as its accuracy is secured by proper standardization. The temperature should be measured near the center of the test structure about 6 ins. below the roof or ceiling, and also at the center of each partition under test about 7 ft. above the grate level. In case the partition under test is more than 15 ft. long, additional pyrometers shall be used, symmetrically disposed and not more than 12 ft. apart. Temperature readings at each point shall be taken every three minutes, and the average used as the controlling temperature.

At the end of the heat test, a stream of water shall be directed against the construction under test, discharged through a 1¼-in. nozzle, under 30 lbs. nozzle pressure, for two and one-half minutes, the nozzle being held within 2 ft. of the firing door and the hose stream being played backward and forward over the entire surface of the partition under test.

The test shall not be regarded as successful unless the following conditions are met: No fire or smoke shall pass through the partition during the fire test; the partition must safely sustain the pressure of the hose stream; the partition must not warp or bulge, or disintegrate under the action of the fire or water to such an extent as to be unsafe.

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STANDARD ABRASION TEST FOR ROAD MATERIAL.

ADOPTED AUGUST 15, 1908.

This well-known test is similar in almost all respects to the Deval abrasion test of the French School of Roads and Bridges. It has been used since 1878, and is entirely satisfactory for the purpose for which it was designed.

ABRASION TEST.

The machine shall consist of one or more hollow iron cylinders; closed at one end and furnished with a tightly fitting iron cover at the other; the cylinders to be 20 cm. in diameter and 34 cm. in depth, inside. These cylinders are to be mounted on a shaft at an angle of 30° with the axis of rotation of the shaft.

At least 30 lbs. of coarsely broken stone shall be available for a test. The rock to be tested shall be broken in pieces as nearly uniform in size as possible, and as nearly 50 pieces as possible shall constitute a test sample. The total weight of rock in a test shall be within 10 grams of 5 kilograms. All test pieces shall be washed and thoroughly dried before weighing. Ten thousand revolutions, at the rate of between 30 and 33 to the minute, shall constitute a test. Only the percentage of material worn off which will pass through a 0.16 cm. (1-16 in.) mesh sieve shall be considered

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in determining the amount of wear. This may be expressed either as the percentage of the 5 kilograms used in the test, or the French coefficient, which is in more general use, may be given; that is, coefficient of wear $= 20 \times \frac{20}{w} = \frac{400}{w}$, where w is the weight in grams of the detritus under 0.16 cm. (1-16 in.) in size per kilogram of rock used.

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STANDARD TOUGHNESS TEST FOR MACADAM ROCK.

ADOPTED AUGUST 15, 1908.

In the consideration of macadam road materials, toughness is understood to mean the power possessed by a material to resist fracture by impact.

In testing macadam rocks under impact, it has been found best to apply a number of blows of successively increasing energy and note the blow causing failure. The following test involving this principle is, therefore, recommended for determining the toughness of rock for macadam road building.

TOUGHNESS TEST.

1. Test pieces may be either cylinders or cubes, 25 mm. in diameter, and 25 mm. in height, cut perpendicular to the cleavage of the rock. Cylinders are recommended as they are cheaper and more easily made.

2. The testing machine shall consist of an anvil of 50 kilograms weight, and placed on a concrete foundation. The hammer shall be of 2 kilograms weight, and dropped upon an intervening plunger of 1 kilogram weight, which rests on the test piece. The lower or bearing surface of this plunger shall be of spherical shape having a radius of 1 cm. This plunger shall be made of hardened steel, and pressed firmly upon the test piece

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by suitable springs. The test piece shall be adjusted, so that the center of its upper surface is tangent to the spherical end of the plunger.

3. The test shall consist of a 1-cm. fall of the hammer for the first blow, and an increased fall of 1 cm. for each succeeding blow until failure of the test piece occurs. The number of blows necessary to destroy the test piece is used to represent the toughness, or the centimeter-grams of energy applied may be used.

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PROVISIONAL METHOD FOR THE DETERMINATION OF SOLUBLE BITUMEN.*

ADOPTED AUGUST 21, 1911.

Drying the Sample and Preparing it for Analysis.—It was decided, owing to the great variety of conditions met with in bituminous compounds, that it is impossible to specify any one method of drying that would be satisfactory in every case. It is therefore supposed that the material for analysis has been previously dried either in the laboratory or in the process of refining or manufacture, and that water, if present, exists only as moisture in the hydroscopic form.

The material to be analyzed, if hard and brittle, is ground and spread in a thin layer in a suitable dish (iron or nickel will answer every purpose) and kept at a temperature of 125° C. for one hour. In the case of paving mixtures and road materials, where it is not desirable to crush the rock or sand grains, a lump may be placed in the drying oven until it is thoroughly heated through, when it can be crushed down into a thin layer and dried as above. If the material under examination contains any hydrocarbons at all volatile at this temperature, it will of course be

* The Committee, in presenting the Provisional Method for the Determination of Soluble Bitumen, wish it understood that they do not recommend it as the best for general use, as it is longer and in many cases gives no better results than other more expeditious methods, but only as a method to be resorted to in case of dispute, as it seems to have the widest range of applicability of any of the methods considered. Moreover, they wish it to be understood that with some classes of materials the method will show a lower percentage of soluble bitumen than many of the shorter methods.

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necessary to resort to other means of drying. Tar or oils may be dehydrated by distillation and the water-free distillate returned to the residue and thoroughly incorporated with it.

Analysis of Sample.—After drying, from 2 to 15 grams (as may be necessary to insure the presence of 1 to 2 grams of pure bitumen) is weighed into a 150-cc. tared Erlenmeyer flask, and treated with 100 cc. of carbon disulphide. The flask is then loosely corked and shaken from time to time until all large particles of the material have been broken up. It is then set aside for 48 hours to settle. The solution is decanted into a similar flask that has been previously weighed. As much of the solvent is poured off as possible without disturbing the residue. The contents of the first flask are again treated with fresh carbon disulphide, shaken as before, and then put away with the second flask for 48 hours to settle.

The liquid in the second flask is then carefully decanted upon a weighed Gooch crucible, 3.2 cm. in diameter at the bottom, fitted with an asbestos filter, and the contents of the first flask are similarly treated. The asbestos filter is made of ignited long-fiber amphibole, packed in the bottom of a Gooch crucible to the depth of not over $\frac{1}{8}$ in. In filtering no vacuum is to be used and the temperature is to be kept between 20° and 25° C. After passing the liquid contents of both flasks through the filter, the residue on the filter is thoroughly washed and the residues remaining in them are shaken with more fresh carbon disulphide and allowed to settle for 24 hours, or until it is seen that a good subsidation has taken place. The solvent in both flasks is then again decanted through the filter and the residues remaining in them are washed until the washings are practically colorless. All washings are to be passed through the Gooch crucible.

The crucible and both flasks are then dried at 125° C. and weighed. The filtrate containing the bitumen is evaporated, the bituminous residue burned, and the weight of the ash thus obtained added to that of the residue in the two flasks and the crucible. The sum of these weights deducted from the weight of substance taken gives the weight of soluble bitumen.

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PROVISIONAL METHOD FOR THE DETERMINATION OF THE PENETRATION OF BITUMEN.

ADOPTED AUGUST 21, 1911.

The penetration of bitumen shall be the distance expressed in hundredths of a centimeter that a No. 2 needle will pentrate into it vertically without friction at 25° C. under a stated weight applied for a stated length of time, the factors of weight and time being determined as follows:

The material shall first be tested for five seconds under a weight of 100 grams. If this result is less than 10, the penetration shall be determined under a weight of 200 grams applied for one minute; if between 10 and 300, the penetration shall be determined under a weight of 100 grams applied for 5 seconds; if greater than 300, the penetration shall be determined under a weight of 50 grams applied for 5 seconds. In every case the factor of weight and time shall be stated when reporting the penetration, and whenever possible to obtain both readings, the penetration under a 100-gram weight for 5 seconds and under the modified weight and time shall both be reported. When testing material softer than 100 penetration, a containing receptacle not less than 1¼ ins. in diameter shall be used.

It is recommended that the penetration may be determined at 0° C. (32° F.) and 46° C. (114°.8 F.), in addition to the 25° C (77° F.) test.

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PROVISIONAL METHOD FOR THE DETERMINATION OF THE LOSS ON HEATING OF OIL AND ASPHALTIC COMPOUNDS.

ADOPTED AUGUST 21, 1911.

The loss on heating of oil and asphaltic compounds shall be determined in the following manner: Twenty grams of the water-free material shall be placed in a circular tin box with vertical sides, measuring about 2 cm. in depth by 6 cm. in diameter, internal measurement. The penetration of the material to be examined shall, if possible, be determined at 25° C. and the exact weight of the sample ascertained. The sample in the tin box shall then be placed in a hot-air oven (New York Testing Laboratory oven without fan), heated to 163° C. (325° F.) and kept at this temperature for 5 hours. At no time shall the temperature of this oven vary more than 2° C. from 163° C. When the sample is cooled to normal temperature, it shall be weighed and the percentage of loss by volatilization reported. The penetration of the residue shall then, if possible, be determined at 25° C. as upon the original material, and the loss in penetration found by subtracting this penetration from the penetration before heating. In preparing the residue for the penetration test it shall first be heated and thoroughly stirred while cooling.

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PROVISIONAL METHOD OF SIZING AND SEPARATING THE AGGREGATE IN ASPHALT PAVING MIXTURES.

ADOPTED AUGUST 21, 1911.

The method consists of passing the mineral aggregate throug several sieves of the following sizes in the order named:

Meshes per linear inch (=2.54 cm.)	Diameter of Wire.	
	Ins.	Mm.
200	0.00235	0.05969
100	0.0045	0.1143
80	0.00575	0.1460
50	0.009	0.22865
40	0.01025	0.26035
30	0.01375	0.34925
20	0.0165	0.4191
10	0.027	0.6858

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STANDARD CLASSIFICATION OF STRUCTURAL TIMBER.

ADOPTED SEPTEMBER 1, 1907.

I. DEFINITION OF STRUCTURAL TIMBER.

By the term "Structural Timber" the Committee understands all such products of wood in which the strength of the timber is the controlling element in their selection and use. The following is a list of products which are recommended for consideration as structural timbers:

Trestle Timbers.—Stringers, caps, posts, mud sills, bracing, bridge ties, guard rails.

Car Timbers.—Car framing, including upper framing; car sills.

Framing for Buildings.—Posts, mud sills, girders, framing, joists.

Ship Timbers.—Ship timbers, ship decking.

Cross Arms for Poles.

II. STANDARD DEFECTS.

Measurements which refer to the diameter of knots or holes should be considered as referring to the mean or average diameter.

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1. *Sound Knot.*—A sound knot is one which is solid across its face and which is as hard as the wood surrounding it; it may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

2. *Loose Knot.*—A loose knot is one not firmly held in place by growth or position.

3. *Pith Knot.*—A pith knot is a sound knot with a pith hole not more than ¼ in. in diameter in the center.

4. *Encased Knot.*—An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than ⅛ in. in width on both sides, not exceeding one-half the circumference of the knot, it shall be considered a sound knot.

5. *Rotten Knot.*—A rotten knot is one not as hard as the wood it is in.

6. *Pin Knot.*—A pin knot is a sound knot not over ½ in. in diameter.

7. *Standard Knot.*—A standard knot is a sound knot not over 1½ ins. in diameter.

8. *Large Knot.*—A large knot is a sound knot, more than 1½ ins. in diameter.

9. *Round Knot.*—A round knot is one which is oval or circular in form.

10. *Spike Knot.*—A spike knot is one sawn in a lengthwise direction; the mean or average width shall be considered in measuring these knots.

11. *Pitch Pockets.*—Pitch pockets are openings between the grain of the wood containing more or less pitch or bark. These shall be classified as *small*, *standard* and *large* pitch pockets.

(*a*) *Small Pitch Pocket.* A small pitch pocket is one not over ⅛ in. wide.

(*b*) *Standard Pitch Pocket.* A standard pitch pocket is one not over ⅜ in. wide, or 3 ins. in length.

(*c*) *Large Pitch Pocket.* A large pitch pocket is one over ⅜ in. wide, or over 3 ins. in length.

12. *Pitch Streak.*—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains,

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that is, the coarse-grained fiber, usually termed "Spring wood," is not saturated with pitch, it shall not be considered a defect.

13. *Wane.*—Wane is bark, or the lack of wood from any cause, on edges of timbers.

14. *Shakes.*—Shakes are splits or checks in timbers which usually cause a separation of the wood between annual rings.

15. *Rot, Dote* and *Red Heart.*—Any form of decay which may be evident either as a dark red discoloration not found in the sound wood, or the presence of white or red rotten spots, shall be considered as a defect.

16. *Ring Shake.*—An opening between the annual rings.

17. *Through Shake.*—A shake which extends between two faces of a timber.

III. STANDARD NAMES FOR STRUCTURAL TIMBERS.

1. *Southern Yellow Pine.*—Under this heading two classes of timber are used, (*a*) Longleaf Pine, (*b*) Shortleaf Pine.

It is understood that these two terms are descriptive of quality, rather than of botanical species. Thus, shortleaf pine would cover such species as are now known as North Carolina pine, loblolly pine, and shortleaf pine. "Longleaf Pine" is descriptive of quality, and if Cuban, shortleaf, or loblolly pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true longleaf, it would be covered by the term "Longleaf Pine."

2. *Douglas Fir.*—The term "Douglas Fir" is to cover the timber known likewise as yellow fir, red fir, western fir, Washington fir, Oregon or Puget Sound fir or pine, norwest and west coast fir.

3. *Norway Pine,* to cover what is known also as "Red Pine."

4. *Hemlock,* to cover Southern or Eastern hemlock; that is, hemlock from all States east of and including Minnesota.

5. *Western Hemlock,* to cover hemlock from the Pacific coast.

6. *Spruce,* to cover Eastern spruce; that is, the spruce timber coming from points east of Minnesota.

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PLATE I.
PROC. AM. SOC. TEST. MATS.
STANDARD CLASSIFICATION OF STRUCTURAL TIMBER.

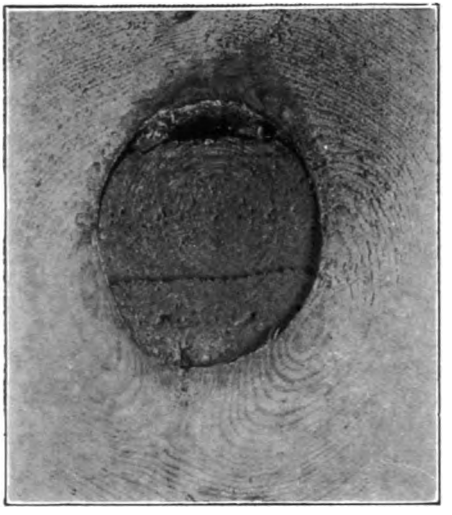


FIG. 1.—Loose Knot.



FIG. 2.—Pith Knot.



FIG. 3.—Encased Knot.



FIG. 4.—Rotten Knot.

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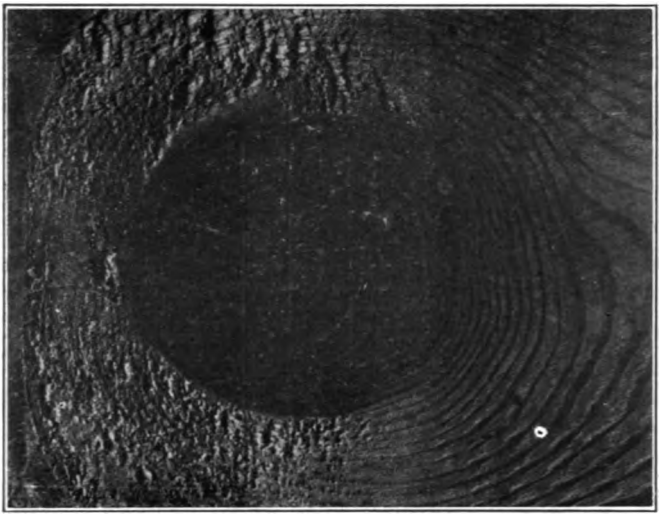


FIG. 6.—Standard Knot.

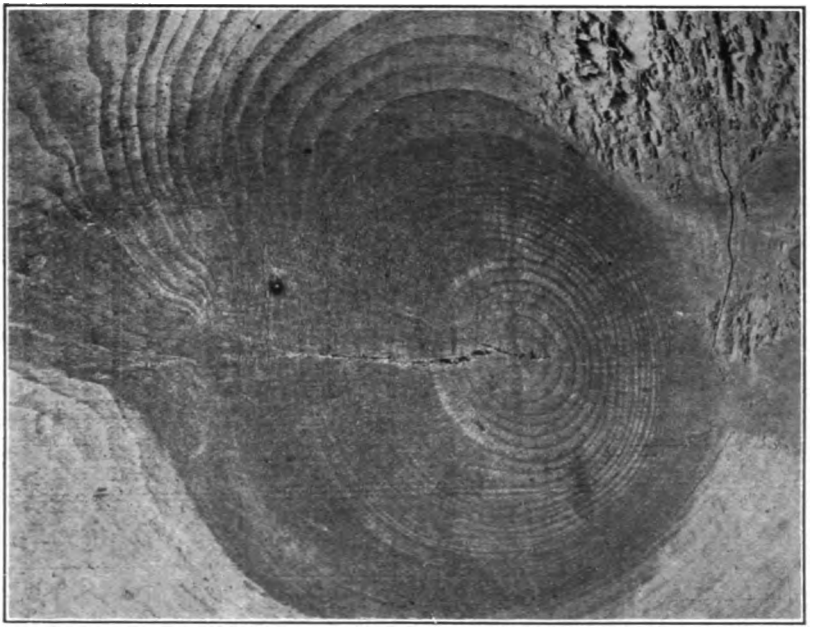


FIG. 7.—Large Knot.

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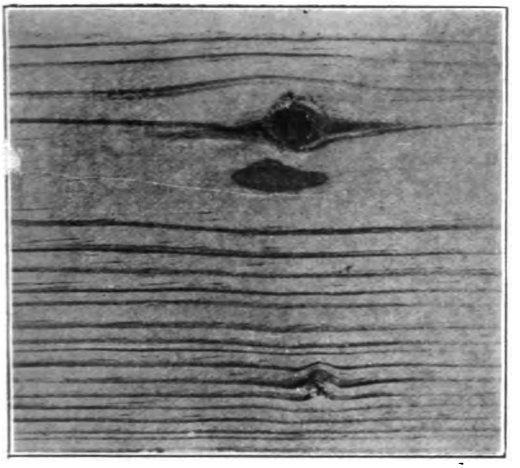


FIG. 5.—Pin Knot.



FIG. 8.—Spike Knot.

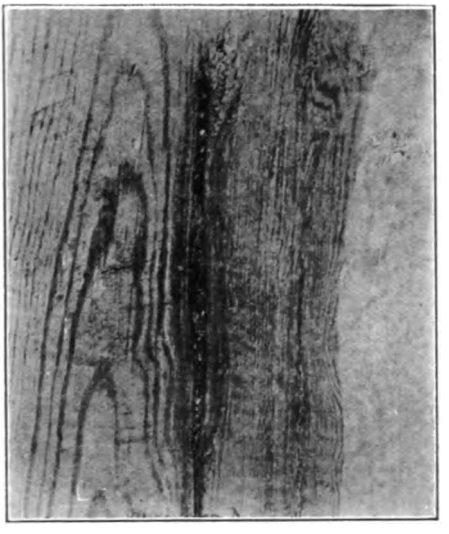


FIG 9.—Pitch Pocket.



FIG. 10.—Pitch Streak.

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7. *Western Spruce*, to cover the spruce timber from the Pacific coast.

8. *White Pine*, to cover the timber which has hitherto been known as white pine, from Maine, Michigan, Wisconsin and Minnesota.

9. *Idaho White Pine*, the variety of white pine from western Montana, northern Idaho, and eastern Washington.

10. *Western Pine*, to cover the timber sold as white pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber sometimes known as "Western Yellow Pine," or "Ponderosa Pine," or "California White Pine," or "Western White Pine."

11. *Western Larch*, to cover the species of larch or tamarack from the Rocky Mountain and Pacific coast regions.

12. *Tamarack*, to cover the timber known as "Tamarack," or "Eastern Tamarack," from States east of and including Minnesota.

13. *Redwood*, to include the California wood usually known by that name.

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STANDARD SPECIFICATIONS FOR YELLOW-PINE BRIDGE AND TRESTLE TIMBERS.

ADOPTED SEPTEMBER 1, 1910.

(To be applied to single sticks and not to composite members.)

GENERAL REQUIREMENTS.

Except as noted, all timber shall be sound, sawed to standard size, square-edged and straight; shall be close-grained and free from defects, such as injurious ring shakes and cross grain, unsound or loose knots, knots in groups, decay, or other defects that will materially impair its strength.

Standard Size of Sawed Timber.—Rough timbers sawed to standard size shall mean that they shall not be over $\frac{1}{4}$ in. scant from the actual size specified. For instance, a 12 by 12-in. timber shall measure not less than $11\frac{3}{4}$ by $11\frac{3}{4}$ ins.

Standard Dressing of Sawed Timber.—Standard dressing shall mean that not more than $\frac{1}{4}$ in. shall be allowed for dressing each surface. For instance, a 12 by 12-in. timber after being dressed on four sides shall measure not less than $11\frac{1}{2}$ by $11\frac{1}{2}$ ins.

STRINGERS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 85 per cent. heart on the girth anywhere in the length of the piece; provided, however, that if the maximum amount of

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sap is shown on either narrow face of the stringer, the average depth of sap shall not exceed ½ in. Knots greater than 1½ ins. in diameter shall not be permitted at any section within 4 ins. of the edge of the piece; but knots shall in no case exceed 4 ins. in their largest diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

CAPS AND SILLS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 85 per cent. heart on each of the four sides, measured across the sides anywhere in the length of the piece, and shall be free from knots over 2½ ins. in diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner, or ½ in. wane on two corners. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

POSTS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 75 per cent. heart on each of the four faces, measured across the sides anywhere in the length of the piece, and shall be free from knots over 2½ ins. in diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner, or ½ in. wane on two corners. Knots must not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

LONGITUDINAL STRUTS AND GIRTS.

Standard Heart Grade. Longleaf Yellow Pine.—One side shall show all heart, and the other side shall show not less than

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85 per cent. heart, measured across the side anywhere in the length of the piece; shall be free from any large knots or other defects that will materially injure its strength.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-edged and sound, and shall be free from any large knots or other defects that will materially injure its strength.

LONGITUDINAL X-BRACES, SASH BRACES AND SWAY BRACES.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show four square corners and not less than 80 per cent. heart on each of two faces, and shall be free from any large knots or other defects that will materially injure its strength.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered and sound, and shall be free from any large knots or other defects that will materially injure its strength.

TIES AND GUARD RAILS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show one side all heart; the other side and two edges shall show not less than 75 per cent. heart, measured across the face anywhere in the length of the piece. Shall be free from any large knots or other defects that will materially injure its strength. Where surfaced, the remaining rough face shall show all heart.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD METHODS OF TESTING.

ADOPTED AUGUST 21, 1911.

I. METHODS FOR TENSILE TESTS OF METALS.

1. Information obtained from the various laboratories in which tensile tests are made shows that in many cases the forms and dimensions of specimens as recommended by the American Society for Testing Materials are in use, and that in other cases these forms and dimensions most nearly reconcile the differences that exist between the various forms employed.

2. It is therefore recommended that the selection of specimens, and their forms and dimensions, shall conform to the specifications for each material, as are now adopted by the American Society for Testing Materials.

3. It is believed that the distance between the end of gauge length and beginning of shoulders, as prescribed in the standard specifications of the American Society for Testing Materials, is ample to avoid interference with proper elongation, and no grounds are found for recommending any change.

4. All information obtained confirms the investigations of Committee O (since dissolved), to the effect that within the limits of speed common in commercial testing, the effect of different speeds on results is not of observable moment; that is, within ranges of speed varying from 1 to 6 ins. per minute.

5. Beyond these limits, however, very rapid loading influences the ultimate strength, which increases with the speed. Whether the elongation is increased or decreased depends somewhat upon

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the nature of the material, though in general very rapidly applied loads will increase the stretch, owing to the elongation occurring over the whole body of the specimen, rather than chiefly at the point of reduction, which is more marked with slowly applied loads.

6. Within the limits of speed customary in determining the modulus of elasticity, it does not appear that the rate of loading influences the value obtained, but whether this value be determined by an autographic attachment to the machine, or by an extensometer on the specimen, it is desirable that the loading be not too rapid, or not over 0.05 in. per minute, to avoid impairing the accuracy of the sensitive devices employed.

7. In determining the modulus of elasticity, the elastic limit (the load at which stress and strain are no longer proportional), and the least load producing a given permanent set, it is considered necessary that the extensometer be attached to two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen.

8. All authorities seem to regard it as desirable to take the stretch on the two sides of the test piece, and most extensometers provide for so doing.

9. The greatest accuracy is required in determining the modulus of elasticity, since small errors in measuring elongation are of considerable consequence in the result.

10. Since the modulus is determined for points well within the elastic limit, the total elongation to be measured is much smaller than at the elastic limit.

11. The elastic limit should be determined with great care, but any inaccuracy will cause less proportionate error than in the case of the modulus. The yield point, being less well defined, cannot be so closely determined, and it is believed that in most cases the use of dividers instead of an extensometer will give sufficiently accurate results.

12. It is considered undesirable in accurate determinations of the modulus of elasticity to use a shorter gauge length than 8 ins. It is evident that the greater the total elongation measured, the less will be the error due to inaccuracy of the reading, and the accuracy thus appears to increase directly as the gauge length.

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13. That the difference between short and long gauge lengths, has a greater influence in affecting results than other factors (personal error, inaccuracy of the testing machine, etc.), is shown by the closely agreeing readings obtained with the greater lengths.

14. The effect of improper methods of holding specimens could not be established from the results of actual tests. The result of improper methods of gripping materials of low stretch, such as cast iron, is well known, and it is probable that in material of a softer nature, the effect is largely local and does not extend to the portion of the specimen within the gauge marks.

Conditions to Ensure Correct Testing Machines.—1. It is recommended that in machines on which specimen tests are made, whether the power be applied hydraulically or by means of screws and gears, the load be measured by a separate system of levers and knife edges, or by a method similar to that employed in the Emery testing machines at the Watertown Arsenal.

2. All knife edges shall be kept sharp, and free from oil and dirt, and the machine shall be sensitive to a variation in load of one two-hundred-and-fiftieth of the load carried. Design and workmanship on testing machines shall be good, and they shall be calibrated at least once every six months by the following method:

Calibration of Testing Machines.—1. Test for accuracy by loading the weighing table with standard weights, and compare the actual weight at each addition with the reading of the beam. If the table is uniformly loaded in this manner with the full amount of weights that it will accommodate, the proportionality of the levers and the weighing beam can be successfully established. This relation, in a properly designed machine, will remain constant for all loads, but as a further test for sensitiveness under greater loads than can be accommodated in this manner, the following procedure is recommended:

2. Place in the machine a tension bar of such cross section that the maximum capacity will not stress it to the elastic limit. Stress this bar to various extents through the full range of the machine, and at each load balance the beam and place upon the weighing table standard weights of 100 lbs. A weight one two-hundred-and-fiftieth of the total load on the machine should produce a readable movement of the beam.

3. Where evidence of the accuracy of the machine over its

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(*b*) The specimen shall be placed in the exact center of the heads, and be secured in some positive manner, so that slip and side bending stresses do not occur.

(*c*) The extensometer should be of a type to measure the elongation on opposite sides of the specimen, and when adjusted the points of attachment should be exactly opposite each other.

(*d*) It should read to ten-thousandths of an inch or less.

(*e*) It should be of such a design that no change of zero will occur upon release of the load in determining the real elastic limit.

(*f*) The load shall be applied so slowly that simultaneous readings of elongation and load can be obtained with certainty.

(*g*) The testing machine shall have previously been calibrated for accuracy and sensitiveness, and heads lined up and made parallel.

II. METHODS FOR COMPRESSIVE TESTS OF METALS.

1. The test specimen shall be a cylinder having plane ends truly normal to its axis.

Only two replies from testing laboratories mention cubes. A cylindrical specimen will usually be cheaper to prepare than a cube. The stresses are probably less uniformly distributed over a square than over a circular section, owing to the influence of the corners, this being especially the case with the internal shearing stresses which accompany the compression.

2. The diameter of the specimen shall be not less than 1 in. nor greater than 1.13 ins. A specimen 1 in. in diameter is to be preferred.

The range of diameter mentioned in the replies from testing laboratories is from 1 in. to 1.129 ins. A diameter of 1.1284 ins. gives a section area of 1 sq. in.

3. The length of the specimen should be between 2.5 and 4 diameters.

Two testing laboratories use a length of 1 diameter, one a length of from 1.5 to 2 diameters, one a length of 2.6 diameters, and one a length of 10.5 diameters. It is believed that a length less than 2.5 diameters is

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not sufficient for the internal shear to be properly developed, and that such short lengths give a fictitious strength owing to the friction of the bearing plates of the machine, which causes the specimen to assume a barrel-like form.

4. No bedding should be used for the ends of the specimen.

Only one reply favors bedding. It is known by general experience that bedding modifies the breaking load and that different kinds of bedding have different influences.

5. The bearing blocks which transmit the pressure from the testing machine should be truly normal to the plane ends of the specimen. To secure this, one of the blocks should be provided with a hemispherical bearing which can turn freely.

These requirements seem essential in order that the load may not be eccentrically applied to the specimen, and are generally recommended in the replies from testing laboratories.

6. The speed of compression should be slow, not exceeding 0.1 in. per minute. Near the elastic limit and yield point the load should be increased very slowly.

A lower speed than that stated might be advisable if permitted by the testing machine. Evidently a higher speed may be allowed with a long specimen than with a short one.

7. For determining modulus of elasticity, the linear compression of the specimen should be observed by a precise compressometer which is attached to the specimen and does not touch the bearing blocks of the machine. Readings of the compressometer should be taken for three loads, the first at about one fourth, the second at about one half, and the third at about three fourths of the elastic limit.

It is believed that these measurements are sufficient for most commercial work. Nothing is said about the release of the specimen from load, since opinions differ as to its advisability.

8. To determine the elastic limit, several readings of the compressometer should be taken as that limit is approached for load increments of 1,000 lbs. per sq. in.

This requirement seems sufficient to determine the proportional elastic limit for materials in which such a limit exists. It does not seem wise to require the first permanent set to be observed for ordinary commercial work.

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9. The yield point is to be noted as corresponding to that load for which the compressometer shows a linear compression without an increase in load. In the absence of a compressometer this point may be noted, for ductile materials, by the drop of the scale beam.

This requirement corresponds to the usual practice of testing laboratories. It is regarded as important that the term "elastic limit" should not be used to designate the yield point.

10. Measurements for the modulus of elasticity, elastic limit, and yield point may be made, if desired, on a specimen ranging in length from 10 to 15 diameters.

This clause is inserted because it may often be difficult to apply a compressometer in a length shorter than 4 ins.

11. The record of the test should mention any phenomena observed near the elastic limit and yield point. The manner of final failure should also be noted when the test is carried to this limit.

This requirement furnishes data for comparing the behavior of brittle and ductile metals near critical points of molecular change.

III. METHODS FOR TRANSVERSE TESTS OF METALS.

1. In the case of cast metals, when transverse tests are to be used to aid in determining the quality of the material, the specimen used shall be cast vertical, shall be 1¼ ins. in diameter, and long enough to use a span of at least 15 times the diameter.

It is important that a definite and uniform standard be adopted so that the results may be comparable with each other; hence the diameter specified above (sectional area corresponding to practically one square inch). The determination of span is at present the subject of international tests to decide upon a definite distance to replace the present standard of 12 ins. It will probably be 16 to 18 ins.

The circular section will best secure a uniform thickness of skin, and thus avoid this irregularity when other sections are employed.

In the case of ductile materials (except in impact tests) transverse tests shall never be used to determine the quality of the material, tensile tests being those suitable for the purpose.

In small round or square bars of ductile material, both the modulus of rupture and the transverse elastic limit vary considerably with the span.

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In the case of tests made for determining constants to be used for designing, the specimen shall conform as nearly as possible with the form and size of the piece to be used. Thus, if I or T sections are to be used, the specimens shall be of I or T section. In the case of flat springs or plate glass, they shall be flat; in the case of timber, rectangular; etc.

It is well known that the modulus of rupture varies with the shape of the section, being very much greater in the case of round than in I sections. Hence the modulus of rupture suitable for use for one would be entirely unsuitable for the other.

In rolled sections, the smaller ones are subjected to a more thorough working in the process of rolling than the larger.

2. In the case of the "Arbitration Bar" adopted for cast iron, the span has been fixed at 12 ins., but may be extended as above stated. The bar will serve for cast and brittle materials.

In the case of ductile materials, when the modulus of rupture is desired, the span shall generally be less than 12 or 15 times the depth. Exceptions, however, occur, as in flat springs and in some cases in full-size pieces, when the spans and methods of supporting the ends, etc., shall conform to the conditions of service.

3. In the case of cast and brittle metals, the speed of testing shall not exceed 0.2 in. per minute. For other specimens the speed shall be correspondingly low.

4. The preparation of the specimen shall be such that it truly represents the material itself. The introduction of extraneous influences should be avoided as far as the knowledge of the material will permit. Thus, in cast metals no coupons shall be used; cast materials for tests shall go into dry molds standing vertical.

No specimen shall be machined before testing, except when information is specifically desired regarding the strength of such machined specimens.

5. The transverse yield point for ductile materials shall be noted approximately by the drop of the scale beam.

6. If the transverse elastic limit is to be determined for comparison with that obtained in the tensile test, the successive increments of load in the neighborhood of the transverse elastic limit shall be comparatively small, and after each load has been applied and the corresponding deflection measured by means of the deflectometer, the load shall be removed and the deflection measured again to determine the permanent set.

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In those cases where the arbitration bar is used for such cast materials as have an elastic limit, the increment of load used near the transverse elastic limit shall be 250 lbs.

It is well known that when the transverse elastic limit is determined, of course by means of a transverse test, the extreme fiber stress at this transverse elastic limit is not the same as that at the tensile elastic limit of the material; and moreover, that it varies with both the section and the span; hence the desirability of comparing the transverse elastic limit with the tensile elastic limit.

7. In the case of ductile materials, the arrangement of the supports shall be such that longitudinal tension in the specimen due to the rigidity of the supports is avoided.

8. In the case of ductile materials, special care shall be used when determining the ultimate load. For this purpose it will be necessary when approaching the ultimate (i.e., the maximum) load, to make the speed of testing slow enough to enable the observer to note the maximum load.

In many cases, as in I and T beams, the maximum load can be easily ascertained, while in others, such as round or flat sections with short spans, it may not be possible to determine it exactly; but it will almost always be possible to determine it with sufficient accuracy for all practical purposes.

IV. METHODS FOR METALLOGRAPHIC TESTS OF METALS.

For general work the following notes are submitted:

Microscopic Examination.—For unhardened iron and steel, the following process has given satisfaction:

1. After polishing, examine under a magnification of 50 to 150 diameters. Look for slag or cinder in wrought iron, manganese sulphide, etc., in steel,* and size and shape of graphite in cast iron.

2. Etch with a saturated solution of picric acid in alcohol for 15 seconds. This reveals the pearlite† by turning it darker than the accompanying ferrite or cementite. In wrought iron, any pearlite present shows up, and the general appearance will sometimes show whether the material was puddled, etc., or made from reheated scrap. Those who wish to bring out the ferrite grains

*Arnold and Waterhouse, *Jour. Iron and Steel Inst.*, 1903, I, 136; E. F. Law, *Jour. Iron and Steel Inst.* 1907 II, 94; Fay, *Proc. Am. Soc. Test. Mat.*, 1908, VIII, 74.

†Igevsky, *Rev. de Met.* II; Lejeune, *Rev. de Met.*, III, 426.

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can do so easily and quickly by etching with nitric acid. To this end, nitric acid of 1.42 specific gravity should be diluted with either:

(*a*) 90 parts by volume of water to 10 of acid,
(*b*) 75 " " " " " " 25 " " or preferably
(*c*) 96 " " " " amyl alcohol to 4 of acid.

3. Near the eutectoid point, viz., 0.6 to 1.0 per cent. carbon, it is often difficult to distinguish between thin envelopes of ferrite and cementite. This difficulty can be overcome by etching with a solution of sodium picrate, which turns cementite dark brown or black but does not color the other constituents. The solution is made by adding 2 parts of picric acid to 98 parts of a solution containing 25 per cent. of caustic soda, and is used at 100° C.*

In order to interpret the results of such an etching, they should be compared with standard etched specimens.

In the case of hardened and tempered steel the indications are less decisive than in the case of unhardened steel, probably because the former class has been studied less than the latter. Coarse grain, segregation of constituents, presence of oxide, etc., are all signs of bad material. For etching use a solution of 4 per cent. nitric acid, specific gravity 1.42, in 96 of amyl alcohol. The time needed has to be found by trial in each case. Hence etch for 5 seconds, examine, re-etch if necessary,† etc.

Macroscopic Examination.—This method shows up defects due to segregation, blowholes, piping, and the like, and when used in connection with microscopic examination yields valuable information. A section is cut with a saw, filed smooth, and polished with No. 0 and No. 00 emery paper; it is then ready for etching.

Quite a number of etching reagents have been used‡ to develop the structure. Whichever solution is chosen, the specimen is first carefully washed with a strong caustic potash solution, well rinsed under the tap, and then immersed in the etching solution. The following may be mentioned:

* Kourbatoff, *Rev. de Met.*, III, 648.

† Kourbatoff, *Rev. de Met.*, III, 648; Lejeune, *Rev. de Met.*, III, 426; Heyn, Mitt. aus dem König. Materialsprüf. Gross-Lichterfelde, West, 1906, 29.

‡ Premont, *Rev. de Met.*, V, 669. Ast. Internat. Assoc. Test. Materials, 1907. IVth Congress. Problem 2.

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(*a*) Freshly prepared solution of 20 grams of I and 30 grams of KI, in 1,000 grams of water.
(*b*) Dilute HCl or H_2SO_4 up to 30 per cent. acid, using the 1.2 and 1.84 specific gravity respectively.
(*c*) Nitric acid, from 10 to 30 per cent. of the 1.42 specific gravity* acid in 90 to 70 per cent. of water.
(*d*) Concentrated HCl, specific gravity 1.2.
(*e*) A solution of 10 or 12 parts of double copper-ammonium chloride in 90 or 88 parts of water.

To bring out the structure of wrought iron rapidly, (*d*) is used, while (*c*) or (*b*) will bring it out more slowly.

For steel, first etch with (*a*), which shows up the segregation of carbon very well. Take care not to over-etch; 5 seconds is enough for some materials. To show up the impurities and the segregation of MnS, slag, etc., (*d*) acts quickly, but (*b*) gives better results though taking longer.

Some prefer light etching, say after 1 or 2 minutes, but an older method is to etch with (*b*) very deeply, indeed to a depth so great that several hours may be needed to reach it. In this way the segregation of the carbon and the impurities like slag and MnS are shown simultaneously. A picture of the object thus etched can be had by treating it like an engraving, i. e., inking it with printer's ink, and printing on white paper directly from it. A com mon letter-copying press is convenient for this printing.

* Stead, *Proc. Cleveland Inst. of Engrs.*, Sept., 1906, p. 3.

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SELECTED SPECIFICATIONS

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AMERICAN RAILWAY ENGINEERING ASSOCIATION.

GENERAL SPECIFICATIONS FOR STEEL RAILWAY BRIDGES.

1910

V. MATERIAL.

Steel. 85. Steel shall be made by the open-hearth process.

Properties. 86. The chemical and physical properties shall conform to the following limits:

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, maximum.. { Basic..	0.04 per cent.	0.04 per cent.	0.05 per cent.
Acid...	0.06 "	0.04 "	0.08 "
Sulphur, maximum.....	0.05 "	0.04 "	0.05 "
Ultimate tensile strength. Pounds per sq. in.....	Desired. 60,000	Desired. 50,000	Not less than 65,000
Elong., min. per cent. in 8 ins. (Fig. 1).....	1,500,000* Ult. tensile str'gth	1,500,000 Ult. tensile str'gth	
Elong., min. per cent. in 2 ins. (Fig. 2).....	22		15 per cent.
Character of fracture.....	Silky	Silky	Silky or fine granular
Cold bends without fracture.....	180° flat†	180° flat‡	90° $d = 3t$

* See Paragraph 96. † See Paragraphs 97, 98, and 99. ‡ See Paragraph 100.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

87. In order that the ultimate strength of full-sized annealed eye-bars may meet the requirements of Paragraph 163§, the ultimate strength in test specimens may be determined by the manufacturers; all other tests than those for ultimate strength shall conform to the above requirements.

§ 163. In eye-bar tests, the minimum ultimate strength shall be 55,000 lbs. per sq. in. The elongation in 10 ft., including fracture, shall be not less than 15 per cent. Bars shall generally break in the body and the fracture shall be silky or fine granular, and the elastic limit as indicated by the drop of the mercury shall be recorded. Should a bar break in the head and develop the specified elongation, ultimate strength and character of fracture, it shall not be cause for rejection, provided not more than one-third of the total number of bars break in the head (see 136).

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88. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same gauge, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate. **Allowable Variations.**

89. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which **Chemical Analyses.**

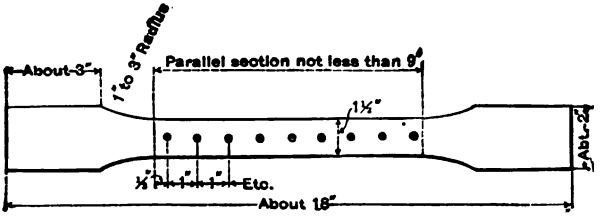


FIG. 1.

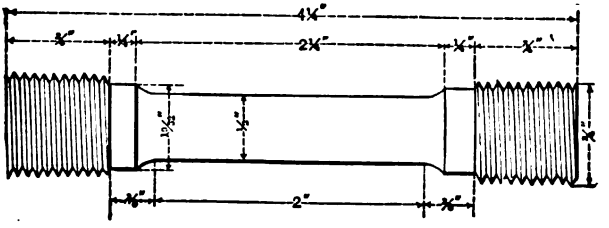


FIG. 2.

case an excess of 25 per cent. above the required limits will be permitted.

90. Plate, shape and bar specimens for tensile and bending tests shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾ in. for a length of at least 9 ins., with enlarged ends. **Specimens.**

91. Rivet rods shall be tested as rolled.

92. Pin and roller specimens shall be cut from the finished rolled or forged bar, in such manner that the center of the specimen

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shall be one inch from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be 1 in. by ½ in. in section.

93. For steel castings the number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from coupons molded and cast on some portion of one or more castings from each melt or from the sink heads, if the heads are of sufficient size. The coupon or sink head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

Specimens of Rolled Steel.

94. Rolled steel shall be tested in the condition in which it comes from the rolls.

Number of Tests.

95. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing ⅜ in. and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Modification in Elongation.

96. A deduction of 1 per cent. will be allowed from the specified percentage for elongation, for each ⅛ in. in thickness above ¾ in.

Bending Tests.

97. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than 1 in. thick shall bend as called for in Paragraph 86.

Thick Material.

98. Full-sized material for eye-bars and other steel 1 in. thick and over, tested as rolled, shall bend cold 180° around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Bending Angles.

99. Angles ¾ in. and less in thickness shall open flat, and angles ½ in. and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test shall be made only when required by the inspector.

Nicked Bends.

100. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine silky uniform fracture.

Finish.

101. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 ins. in width and under shall have rolled edges.

Melt Numbers.

102. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it.

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Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Defective Material.

103. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Variation in Weight.

104. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates, when ordered to weight:

105. Plates 12½ lbs. per sq. ft. or heavier:

(*a*) Up to 100 ins. wide, 2½ per cent. above or below the prescribed weight.

(*b*) 100 ins. wide and over, 5 per cent. above or below.

106. Plates under 12½ lbs. per sq. ft.:

(*a*) Up to 75 ins. wide, 2½ per cent. above or below.

(*b*) 75 ins. and up to 100 ins. wide, 5 per cent. above or 3 per cent. below.

(*c*) 100 ins. wide and over, 10 per cent. above or 3 per cent. below.

107. Plates when ordered to gauge will be accepted if they measure not more than 0.01 in. below the ordered thickness.

108. An excess over the nominal weight, corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, ins.	Nominal Weights, lbs.	Width of Plate.			
		Up to 75 ins.	75 ins. and up to 100 ins.	100 ins. and up to 115 ins.	Over 115 ins.
1/4	10.20	10 per cent.	14 per cent.	18 per cent.	....
5/16	12.75	8 "	12 "	16 "	....
3/8	15.30	7 "	10 "	13 "	17 per cent.
7/16	17.85	6 "	8 "	10 "	13 "
1/2	20.40	5 "	7 "	9 "	12 "
9/16	22.95	4½ "	6½ "	8½ "	11 "
5/8	25.50	4 "	6 "	8 "	10 "
Over 5/8	.....	3½ "	5 "	6½ "	9 "

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Cast Iron. 109. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded, they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar $1\frac{1}{4}$ ins. in diameter and 15 ins. long. The transverse test shall be made on a supported length of 12 ins. with load at middle. The minimum breaking load so applied shall be 2,900 lbs., with a deflection of at least 0.1 in. before rupture.

Wrought Iron. 110. Wrought iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent. in 8 ins., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135°, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent, the fracture shall show at least 90 per cent. fibrous.

VI. INSPECTION AND TESTING AT THE MILLS.

Mill Orders. 111. The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled nor work done before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection.

Facilities for Inspection. 112. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

Access to Mills. 113. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured.

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THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL.

1. Steel may be made by either the open-hearth or Bessemer process. **Process of Manufacture.**

2. All tests and inspections shall be made at the place of manufacture prior to shipment. **Testing and Inspection.**

3. The tensile strength, limit of elasticity and ductility, shall be determined from a standard test piece cut from the finished material. The standard shape of the test piece for sheared plates shall be as shown by Fig. 1. **Test Pieces.**

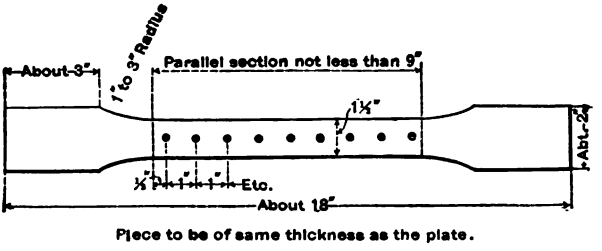


FIG. 1.

On tests cut from other material the test piece may be either the same as for sheared plates, or it may be planed or turned parallel throughout its entire length, and in all cases where possible, two opposite sides of the test piece shall be the rolled surfaces. The elongation shall be measured on an original length of 8 ins., except as modified in Section 12, Paragraph *c*. Rivet rounds and small bars shall be tested of full size as rolled.

Two test pieces shall be taken from each melt or blow of finished material, one for tension and one for bending; but in case either test develops flaws, or the tensile test piece breaks

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outside of the middle third of its gauged length, it may be discarded and another test piece substituted therefor.

nnealed est Pieces.

4. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material shall be similarly treated before testing.

larking.

5. Every finished piece of steel shall be stamped with the blow or melt number, and steel for pins shall have the blow or melt number stamped on the ends. Rivet and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

inish.

6. Finished bars shall be free from injurious seams, flaws or cracks, and have a workmanlike finish.

hemical roperties.

7*a*. Steel for Buildings, Train Sheds, Highway Bridges and Similar Structures } Maximum Phosphorus, 0.10 per cent.

7*b*. Steel for Railway Bridges.....Maximum Phosphorus, 0.08 per cent.

hysical roperties.

8. Structural Steel shall be of three grades, Rivet, Railway Bridge, and Medium.

ivet Steel.

9. Ultimate strength.....48,000 to 58,000 lbs. per sq. in.
Elastic limit.....not less than one-half the ultimate strength.
Percentage of elongation... $\frac{1{,}400{,}000}{\text{ultimate strength.}}$
Bending test.....180° flat on itself, without fracture on outside of bent portion.

eel for ailway Bridges.

10. Ultimate strength.....55,000 to 65,000 lbs. per sq. in.
Elastic limit.....not less than one-half the ultimate strength.
Percentage of elongation... $\frac{1{,}400{,}000}{\text{ultimate strength.}}$
Bending test.....180° to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

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11. Ultimate strength.....60,000 to 70,000 lbs. per sq. in. **Medium Steel.**
Elastic limit.....not less than one-half the ultimate strength.
Percentage of elongation...$\frac{1,400,000}{\text{ultimate strength.}}$
Bending test.....180° to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

12. For material less than $\frac{5}{16}$ in., and more than $\frac{3}{4}$ in. in thickness, the following modifications shall be made in the requirements for elongation: **Modifications in Elongation for Thin and Thick Material.**

(*a*) For each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., a deduction of 1 per cent. shall be made from the specified elongation, except that the minimum elongation shall be 20 per cent. for eye-bar material and 18 per cent. for other structural material.

(*b*) For each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in., a deduction of $2\frac{1}{2}$ per cent. shall be made from the specified elongation.

(*c*) In rounds of $\frac{5}{8}$ in. or less in diameter, the elongation shall be measured in a length equal to eight times the diameter of section tested.

(*d*) For pins made from any of the before-mentioned grades of steel, the required elongation shall be 5 per cent. less than that specified for each grade, as determined on a test piece, the center of which shall be one inch from the surface of the bar.

13. The variation in cross-section or weight of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations: **Variation in Weight.**

(*a*) Plates $12\frac{1}{2}$ lbs. per sq. ft. or heavier, up to 100 ins. wide, when ordered to weight, shall not average more than $2\frac{1}{2}$ per cent. variation above or $2\frac{1}{2}$ per cent. below the theoretical weight; when 100 ins. wide and over, 5 per cent. above or 5 per cent. below the theoretical weight.

(*b*) Plates under $12\frac{1}{2}$ lbs. per sq. ft., when ordered to weight, shall not average a greater variation than the following:

Up to 75 ins. wide, $2\frac{1}{2}$ per cent. above or $2\frac{1}{2}$ per cent. below the theoretical weight; 75 ins. wide up to 100 ins. wide,

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5 per cent. above or 3 per cent. below the theoretical weight; when 100 ins. wide and over, 10 per cent. above or 3 per cent. below the theoretical weight.

(*c*) For all plates ordered to gauge there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE.

Plates will be considered up to gauge if measuring not over 0.01 in. less than the ordered gauge.

The weight of one cubic inch of rolled steel is assumed to be 0.2833 lb.

Plates ¼ in. and over in thickness.

Thickness of Plate, ins.	Width of Plate.			
	Up to 75 ins., per cent.	75 ins. to 100 ins., per cent.	100 ins. to 115 ins., per cent.	Over 115 ins., per cent.
1/4..	10	14	18	..
5/16.	8	12	16	..
3/8..	7	10	13	17
7/16.	6	8	10	13
1/2..	5	7	9	12
9/16.	4½	6½	8½	11
5/8..	4	6	8	10
Over 5/8..	3½	5	6½	9

Plates under ¼ in. in thickness.

Thickness of Plate, ins.	Width of Plate.		
	Up to 50 ins., per cent.	50 ins. to 70 ins., per cent.	Over 70 ins., per cent.
1/8 up to 5/32.....	10	15	20
5/32 " 3/16.....	8½	12½	17
3/16 " 1/4.....	7	10	15

STRUCTURAL CAST IRON.

1. Except when chilled iron is specified, all castings shall be tough gray iron, free from injurious cold-shuts or blowholes, true to pattern, and of a workmanlike finish. Sample pieces 1 in. square, cast from the same heat of metal in sand molds, shall be capable of sustaining on a clear span of 4 ft. 8 ins., a central load of 500 lbs. when tested in the rough bar.

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THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS FOR SPECIAL OPEN-HEARTH PLATE AND RIVET STEEL.

1. All tests and inspections shall be made at the place of manufacture prior to shipment. **Testing and Inspection.**

2. The tensile strength, limit of elasticity and ductility shall be determined from a standard test piece cut from the finished material. The standard shape of the test piece for sheared plates shall be as shown by Fig. 1. **Test Pieces.**

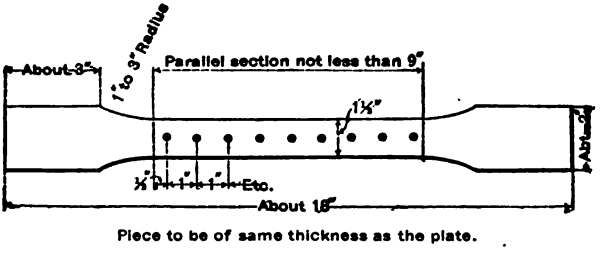


FIG. 1.

On tests cut from other material the test piece may be either the same as for sheared plates, or it may be planed or turned parallel throughout its entire length, and in all cases where possible, two opposite sides of the test piece shall be the rolled surfaces. The elongation shall be measured on an original length of 8 ins., except as modified in Section 12, Paragraph *c*. Rivet rounds and small bars shall be tested of full size as rolled.

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Four test pieces shall be taken from each melt of finished material, two for tension and two for bending; but in case either test develops flaws, or the tensile test piece breaks outside of the middle third of its gauged length, it may be discarded and another test piece substituted therefor.

Annealed Test Pieces.

3. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material shall be similarly treated before testing.

Marking.

4. Every finished piece of steel shall be stamped with the melt number. Rivet steel may be shipped in bundles securely wired together, with the melt number on a metal tag attached.

Finish.

5. All plates shall be free from injurious surface defects and have a workmanlike finish.

Chemical Properties.

6*a*. Flange or Boiler Steel. } Maximum Phosphorus, 0.06 per cent.
" Sulphur, 0.04 " "

6*b*. Extra Soft and Firebox Steel. } " Phosphorus, 0.04 " "
" Sulphur, 0.04 " "

Physical Properties.

7. Special Open-hearth Plate and Rivet Steel shall be of three grades, Extra Soft, Firebox, and Flange or Boiler Steel.

Extra Soft Steel.

8. Ultimate strength.....45,000 to 55,000 lbs. per sq. in.
Elastic limit.....not less than one-half the ultimate strength.
Elongation.....28 per cent.
Cold and Quench bends....180° flat on itself, without fracture on outside of bent portion.

Firebox Steel.

9. Ultimate strength.....52,000 to 62,000 lbs. per sq. in.
Elastic limit.....not less than one-half the ultimate strength.
Elongation.....26 per cent.
Cold and Quench bends....180° flat on itself, without fracture on outside of bent portion.

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10. Ultimate strength.....55,000 to 65,000 lbs. per sq. in. **Flange or Boiler Steel.**
Elastic limit.....not less than one-half the ultimate strength.
Elongation.....25 per cent.
Cold and Quench bends....180° flat on itself, without fracture on outside of bent portion.

11. Steel for boiler rivets shall be made of the extra soft grade specified in Paragraph 8. **Boiler Rivet Steel.**

12. For material less than $\frac{5}{16}$ in., and more than $\frac{3}{4}$ in. in thickness, the following modifications shall be made in the requirements for elongation: **Modifications in Elongation for Thin and Thick Material.**

(*a*) For each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., a deduction of 1 per cent. shall be made from the specified elongation.

(*b*) For each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in., a deduction of $2\frac{1}{2}$ per cent. shall be made from the specified elongation.

(*c*) In rounds of $\frac{5}{8}$ in. or less in diameter, the elongation shall be measured in a length equal to eight times the diameter of section tested.

13. The variation in cross-section or weight of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations: **Variation in Weight.**

(*a*) Plates $12\frac{1}{2}$ lbs. per sq. ft. or heavier, up to 100 ins. wide, when ordered to weight, shall not average more than $2\frac{1}{2}$ per cent. variation above or $2\frac{1}{2}$ per cent. below the theoretical weight; when 100 ins. wide and over, 5 per cent. above or 5 per cent. below the theoretical weight.

(*b*) Plates under $12\frac{1}{2}$ lbs. per sq. ft., when ordered to weight, shall not average a greater variation than the following:

Up to 75 ins. wide, $2\frac{1}{2}$ per cent. above or $2\frac{1}{2}$ per cent. below the theoretical weight; 75 ins. wide up to 100 ins. wide, 5 per cent. above or 3 per cent. below the theoretical weight; when 100 ins. wide and over, 10 per cent. above or 3 per cent. below the theoretical weight.

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(*c*) For all plates ordered to gauge there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE.

Plates will be considered up to gauge if measuring not over 0.01 in. less than the ordered gauge.

The weight of one cubic inch of rolled steel is assumed to be 0.2833 lb.

Plate ¼ in. and over in thickness.

Thickness of Plate, ins.	Width of Plate.			
	Up to 75 ins., per cent.	75 ins. to 100 ins., per cent.	100 ins. to 115 ins., per cent.	Over 115 ins., per cent.
1/4..	10	14	18	..
5/16.	8	12	16	..
3/8..	7	10	13	17
7/16.	6	8	10	13
1/2..	5	7	9	12
9/16.	4½	6½	8½	11
5/8..	4	6	8	10
Over 5/8..	3½	5	6½	9

Plates under ¼ in. in thickness.

Thickness of Plate, ins.	Width of Plate.		
	Up to 50 ins., per cent.	50 ins. to 70 ins., per cent.	Over 70 ins., per cent.
1/8 up to 5/32	10	15	20
5/32 " 3/16.....	8½	12½	17
3/16 " 1/4	7	10	15

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THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS FOR BESSEMER STEEL RAILS.

Process of Manufacture.

1. The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

No bled ingots shall be used.

Sufficient material shall be discarded from the top of ingot to insure sound rails.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 59 lbs. inclusive, per cent.	60 to 69 lbs. inclusive, per cent.	70 to 79 lbs. inclusive, per cent.	80 to 89 lbs. inclusive, per cent.	90 to 100 lbs. inclusive, per cent.
Carbon.....	0.35 to 0.45	0.38 to 0.48	0.45 to 0.55	0.48 to 0.58	0.50 to 0.60
Phosphorus, not over	0.10	0.10	0.10	0.10	0.10
Silicon, not over....	0.20	0.20	0.20	0.20	0.20
Manganese.....	0.70 to 1.00	0.70 to 1.00	0.75 to 1.05	0.80 to 1.10	0.80 to 1.10

Drop Test.

3. One drop test shall be made on a piece of rail not more than 6 ft. long, selected from every fifth blow of steel. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests:

Weight of Rail, lbs. per yd.			Height of Drop, ft.
45 to and including		55	14
More than	55	65	15
" "	65	75	16
" "	75	85	17
" "	85	100	18

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If any rail break when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop test as above specified, two other rails will be subjected to the same tests, one from the blow next preceding, and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall also be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests may be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested if necessary.

The acceptance or rejection of all the rails from any blow will depend upon the result of the tests thereof.

Drop-Testing Machine.

4. The drop-test machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of 5 ins., and the test rail shall be placed head upwards on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs. and the supports shall be a part of, or firmly secured to, the anvil.

The report of the drop test shall state the atmospheric temperature at the time the tests were made.

Sample for Chemical Analysis.

5. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test ingot.

Section.

6. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform as accurately as possible to the templet furnished by the railroad company, consistent with Paragraph 7, relative to specified weight. A variation in height of $\frac{1}{64}$ in. less and $\frac{1}{32}$ in. greater than the specified height will be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

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7. The weight of the rails shall be maintained as nearly as possible, after complying with Paragraph 6, to that specified in contract. A variation of one-half per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weight. **Weight.**

8. The standard length of rails shall be 30 or 33 ft. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 ft. A variation of $\frac{1}{4}$ in. in length from the length specified will be allowed. **Length.**

9. Circular holes for splice bars shall be drilled in accordance with specifications of purchaser. They shall be accurate to drawing and dimensions furnished, in every respect, and free from burrs. **Drilling.**

10. Rails shall be straightened while cold, smooth on head, sawed square at ends, and prior to shipment shall have the burr occasioned by the saw-cutting removed, and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds. **Finish.**

11. The name of the maker and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat shall be stamped on each rail. **Branding.**

12. The inspector, representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment. **Inspection.**

13. Rails which possess any injurious physical defects, or for any other cause are not suitable for first quality, shall be considered No. 2 rails. **No. 2 Rails.**

14. Both ends of all seconds or No. 2 rails to be painted white. Both ends of all short-length first quality or No. 1 rails to be painted green. **Designation of No. 2 Rails, and Short Lengths of No. 1 Rails.**

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UNITED STATES STEEL PRODUCTS EXPORT COMPANY

STANDARD SPECIFICATIONS FOR BESSEMER AND OPEN-HEARTH STEEL RAILS.

MARCH 21, 1910.

Process of Manufacture.

1. (*a*) The steel shall be of the best quality and made by the acid Bessemer or the basic open-hearth (Siemens-Martin) process, as determined by the engineer (or by the purchaser) at the time sale is made.

(*b*) The materials used and the entire process of manufacture and testing shall be in strict accordance with the best standard current practice, and special care shall be taken to conform to the following instructions:

(*c*) The ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has had time to solidify.

(*d*) No "bled" ingots shall be used, and no ingots from "chilled" heats rolled into first quality rails. A "bled" ingot is one from the center of which liquid steel has escaped. A "chilled" heat is one which, because of the cooling of the steel, has to be either pricked or poured over the top of the ladle.

(*e*) Sufficient material shall be discarded or "cropped" from the top of all ingots, to obtain sound rails.

(*f*) The ingots or blooms must be evenly heated throughout their length, drawn at a uniform temperature, and a uniform finishing temperature also maintained.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

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BESSEMER STEEL.

	45 to 60 lbs., per cent.	61 to 70 lbs., per cent.	71 to 80 lbs., per cent.	81 to 90 lbs., per cent.	91 to 100 lbs., per cent.
Carbon....	0.30 to 0.40	0.35 to 0.45	0.35 to 0.45	0.40 to 0.50	0.40 to 0.50
Manganese.	0.70 to 1.00	0.70 to 1.00	0.70 to 1.00	0.80 to 1.10	0.80 to 1.10
Silicon....	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20
Phosphorus	Not over 0.10	Not over 0.10	Not over 0.10	Not over 0.10	Not over 0.10

OPEN-HEARTH STEEL.

	45 to 60 lbs., per cent.	61 to 70 lbs., per cent.	71 to 80 lbs., per cent.	81 to 90 lbs., per cent.	91 to 100 lbs., per cent.
Carbon....	0.40 to 0.55	0.40 to 0.55	0.45 to 0.60	0.55 to 0.70	0.55 to 0.70
Manganese.	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90
Silicon....	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20
Phosphorus	Not over 0.04	Not over 0.04	Not over 0.04	Not over 0.04	Not over 0.04

Chemical Analyses.

3. The manufacturer shall make and furnish to the representative of the engineer (or of the purchaser), before the rails rolled on each turn are ready for shipment, determination of carbon on each heat of Bessemer steel, and average determinations of manganese, phosphorus and silicon representing each twelve-hour rolling; all said analyses to be made on drillings from a test ingot cast when teeming each heat, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of the said test ingot. If requested by the inspector, the manufacturer shall furnish a portion of the test ingot drillings for check analyses. For open-hearth steel, the manufacturers shall furnish a complete analysis for each heat of steel covering the elements specified in Section 2 hereof.

Impact Test.

4. From every heat of steel a test piece of rail from 4 to 6 ft. long shall be cut at the hot saws, and shall be distinctly marked with the heat number and set aside to cool. As soon as cooled, it shall be placed, head upwards, on the supports of the standard American rail drop-testing machine, described below, and the various sections must withstand, without fracture, one blow of the 2,000-lb. tup, from the height specified in the following schedule:

Weight of Rail, lbs. per yd.	Height of Drop, ft.
45	13
50 to 60	14
61 to 70	15
71 to 80	16
81 to 90	17
91 to 100	18

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If any rail breaks when subjected to the drop test, two additional tests shall be made of other rails from the same heat of steel, and if either of these latter tests fail, all the rails of the heat which they represent will be rejected; but if both of these additional test pieces meet the requirements, all the rails of the heat which they represent will be accepted.

The report of drop test shall state the atmospheric temperature at the time the test was made. The temperature of the test pieces, when tested, shall be not less than 60° F., nor greater than 120° F. The testing shall proceed concurrently with the operation of the mill.

The drop-testing machine shall conform essentially to the plans and specifications approved by the American Railway Engineering and Maintenance of Way Association. It shall have a freely falling tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins. The anvil block shall be a solid casting, weighing, with the attachments that move with it, at least 20,000 lbs. The supports, spaced 3 ft. center to center, and having an upper cylindrical bearing surface with a radius of 5 ins., shall be part of or firmly secured to the anvil.

The leads shall be firmly connected to the base plate and well braced; and provided with a properly divided and plainly marked gauge. The tup shall have a tripping head arranged to allow the tongs to release automatically at the exact height for which the tripping device is set and that will also be safe from accidental release while the test piece is being shifted.

Dead Weight Test.

5. A piece of rail 6 ft. long taken as a part of a lot of each 100 tons, placed head upwards on supports spaced 3 ft. center to center, must withstand without permanent set the dead weight test as per schedule below:

DEAD WEIGHT TEST.

Section of Rail.		Load, without Permanent Set, lbs.	Time, minutes.
Height, ins.	Nominal Weight, lbs. per yd.		
3 1/16	45	20,000	5
3 1/4 to 4 1/4	50–60	25,000	5
4 5/16 to 4 1/2	65–70	32,000	5
4 13/16 to 5	75–80	40,000	5
5 3/16 to 5 1/2	85–90	45,000	5
5 5/16 to 5 1/2	95–100	50,000	5

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If any rail fails when subjected to the dead weight test, two additional tests shall be made of other rails from the same lot, and if either of these latter tests fail, all of the rails of the lot which they represent will be rejected; but if both these additional test pieces meet these requirements, all the rails of the lot which they represent will be accepted.

Section. 6. Before the general manufacture of the rails is commenced, the manufacturer shall, if required by the engineer (or by the purchaser), supply two sets of templets, internal and external, made of approved material. These templets engraved as specified in the contract, shall be submitted to the engineer (or to the purchaser) for his approval, and at the commencement of rolling the engineer shall have a competent person present to approve of the section.

The rails shall be of uniform section throughout, and shall conform, as accurately as possible, to the approved templet, consistent with Section 7 relative to specified weight. To allow for the unavoidable wear of the rolls, a variation in height of $\frac{1}{64}$ in. under and $\frac{1}{32}$ in. over, and in width of base of $\frac{1}{16}$ in. shall be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

Weight. 7. The weight of the rails shall be maintained as nearly as possible, after complying with Section 6, to that specified in the contract. A variation of one per cent. for individual carload lots, and of one-half per cent. for an entire order, shall be allowed. The manufacturer shall weigh one rail each hour during the entire rolling. Rails shall be accepted and paid for according to actual track scale weight.

Length. 8. Unless otherwise specified in the contract, the standard length of rails shall be 30 ft. Ten per cent. of the entire order, if made, shall be accepted in shorter lengths, varying by 1 ft. down to but not more than 9 ft. below the standard length specified.

Unless otherwise specified in the contract, a variation in length of $\frac{1}{4}$ in. from that specified shall be permitted for the standard practice of rails hot-sawed to length. If it is specified in the contract that the length of rails shall be obtained by cold machining, a variation of $\frac{1}{8}$ in. from the length specified shall be permitted.

Drilling. 9. Holes for splice bolts shall be drilled through the web, from

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the solid, at each end of the rails and in strict accordance with the drawings of the purchaser. They shall conform accurately to the drawing and dimensions furnished in every respect; shall be clean and square with the web, and shall be left without burrs on either side. Should any of the holes vary from the correct size or position more than $\frac{1}{32}$ in., the rails in question will be liable to rejection.

Branding. 10. The maker's name, initials or other recognized mark, the weight of the rail per yard, and the month and year of manufacture shall be rolled in raised letters on the side of the web.

The heat number shall be plainly stamped on the web of each rail while hot, at a sufficient distance from the end, so that it will not be subsequently covered by the splice bar. Open-hearth rails shall be branded or stamped "O. H." in a similar manner.

Finish. 11. Rails shall be straight in line and surface when finished; the straightening being carefully done while cold; smooth on head, sawed square at ends (variation to be not more than $\frac{1}{32}$ in.), and, prior to shipment, shall have the burr occasioned by the saw-cutting carefully chipped and filed off, particularly under the head and on top of the flanges; the ends must be clean.

No. 1 rails are to be free from injurious defects and flaws of all kinds.

Inspection. 12. The manufacturer shall give the engineer (or the purchaser), or his inspector, if so instructed, a reasonable notice, in writing, before rolling shall be begun, and similar written notices in advance of each resumption of rolling, in case the order is not filled at one continuous rolling. Should the maker fail to give said notice, all rails rolled in the absence of the duly authorized representative may be rejected as part of the contract. The party thus notified shall, in turn, give written notice to the manufacturer of his intentions to be present, or permission to proceed at the time designated by the maker.

Authorized representatives shall have free access to the works of the manufacturer at all times when the contract is being filled, and shall have, free of cost, all reasonable facilities afforded by the maker to satisfy them that the finished rails are furnished in accordance with the terms of these specifications; the inspection shall, therefore, be conducted so as to cause no serious delays in the processes of manufacture.

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All tests and inspection shall be made at the place of manufacture, and the engineer, or his representative at the mill, shall be empowered to give the necessary written certificates of acceptance to the manufacturer, in such a manner as not to cause delays in the shipment of inspected rails.

Seconds or No. 2 Rails.

13. Rails which possess any injurious defects, or which, from any other cause, are not suitable for first quality, or No. 1 rails, shall be considered as "seconds" or No. 2 rails.

They shall not have flaws in their heads of more than $\frac{1}{4}$ in., or in the flange of more than $\frac{1}{2}$ in. in depth, and, in the judgment of the inspector, these shall not be so numerous or of such a character as to render them unfit for recognized No. 2 rail uses.

No. 2 rails shall be accepted up to 5 per cent. of the whole order unless otherwise provided in contract.

Designation of No. 2 Rails and Short Lengths of No. 1 Rails.

14. Both ends of all No. 2 rails shall be painted white. Both ends of all short length No. 1 rails shall be painted green.

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OFFICERS

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

President,
HENRY M. HOWE

Vice-President,
ROBERT W. LESLEY

Secretary-Treasurer,
EDGAR MARBURG

Office: University of Pennsylvania, Philadelphia, Pa.

MEMBERS OF THE EXECUTIVE COMMITTEE.

Term Expiring in 1912.

Term Expiring in 1913.

W. A. BOSTWICK, RICHARD MOLDENKE,
ROBERT W. HUNT, WILLIAM R. WEBSTER.

STANDING COMMITTEES.

Committee on Finance.

WILLIAM R. WEBSTER, *Chairman,*
W. A. BOSTWICK, ROBERT W. LESLEY.

Committee on Membership.

————, *Chairman,*
EDGAR MARBURG, RICHARD MOLDENKE.

Committee on Publications.

ROBERT W. HUNT, *Chairman,*
ROBERT W. LESLEY, EDGAR MARBURG.

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RULES GOVERNING THE EXECUTIVE COMMITTEE.

Regular meetings shall be held on the second Tuesday in January, April, July and October. Four members shall constitute a quorum.

At each meeting the Secretary shall report the names of all new members and of members who have resigned during the previous quarter, and shall present a financial statement.

At the January meeting the Secretary shall report the names of all members whose dues are unpaid.

The accounts of the Treasurer shall be duly audited at the middle and close of each fiscal year, and the report of the auditors shall be presented in writing at the July and January meetings.

Special meetings may be held at any time at the call of the President, or upon the written request of four members of the Executive Committee. The notice for such meetings shall be mailed by the Secretary at least one week in advance of the meeting, and the business shall be stated in the notice.

The Secretary shall transmit the net balance to the credit of the International Association on January 1, April 1, and July 1 to that Association within five days from the dates mentioned.

No expenditures shall be made except on vouchers certified to be correct by the Chairman of the Committee on Finance, or a member thereof designated by the Chairman.

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LIST OF MEMBERS

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Members holding membership also in the International Association for Testing Materials are distinguished thus (*).

Life Members are distinguished thus (†).

Junior Members are distinguished thus (‡).

ELECTED.

ABBOTT, FRANKLIN E. (see *Lackawanna Steel Company*).

1907. *‡ABRAHAM, HERBERT. Chemist, Standard Paint Company, Bound Brook, N. J.

1906. *ABRAMS, D. A. Assistant, Laboratory of Applied Mechanics, University of Illinois, Urbana, Ill.

ACKER, E. O'C. (see *Bethlehem Steel Company*).

1905. ADAIR, ARTHUR P. Civil Engineer, Suite 241, Sonna Block, Boise, Idaho.

1909. ADAMS, H. C. Vice-President, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pa.

1911. ADAMS, H. H. Superintendent, Rolling Stock and Shops, Metropolitan Street Railway, 775 Seventh Avenue, New York, N. Y.

1910. *ADAMS, JOHN K. President, The Flexol Company, 27 East Twenty-second Street, New York, N. Y.

1910. ADDICKS, LAWRENCE. Superintendent, United States Metals Refining Company, Chrome, N. J.

1909. *AERTSEN, GUILLIAEM. With Midvale Steel Company, 611 Phil Ellena Street, Stenton, Philadelphia, Pa.

1904. AIKEN, CHARLES W. Consulting Engineer, 39 Fifty-third Street, Brooklyn, N. Y.

1902. AIKEN, W. A. Inspecting Engineer, Henry S. Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1902. *AJAX METAL COMPANY. G. H. Clamer, Second Vice-President and Secretary, 46 Richmond Street, Philadelphia, Pa.

1910. AKIN, THOMAS B. Master Painter, Box 422, New Bedford, Mass.

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ELECTED.

ALDRICH, WILLIAM S. (see *Clarkson Memorial School of Technology*).

1910. *ALLAN, ANDREW, JR. Member of firm, A. Allan and Son, 486 Greenwich Street, New York, N. Y.

1903. ALLEN, A. W. Superintendent, Open-Hearth Department, Tennessee Coal, Iron and Railroad Company, 1616 South Fourteenth Avenue, Birmingham, Ala.

ALLEN, FRANCIS B. (see *Hartford Steam Boiler Inspection and Insurance Company*).

1905. ALLEN, HENRY C. City Engineer, Syracuse, N. Y.

1910. *ALLEN, IRVING C. Petroleum Chemist, United States Bureau of Mines, Fortieth and Butler Streets, Pittsburg, Pa.

ALLEN, W. F. (see *American Railway Association*).

1910. *ALUMINUM CASTINGS COMPANY, THE. H. W. Gillet, Manager, Research Department, Detroit, Mich.

1910. ‡ALVAREZ, ARTHUR C. Instructor in Civil Engineering, University of California, 1909 Dwight Way, Berkeley, Cal.

1905. AMERICAN ASPHALTUM AND RUBBER COMPANY. H. B. Pullar, Manager of Laboratory, Harvester Building, Chicago, Ill.

1903. *AMERICAN BRASS COMPANY. William H. Bassett, Chemist, Waterbury, Conn.

1902. AMERICAN BRIDGE COMPANY. C. W. Bryan, Chief Engineer, 30 Church Street, New York, N. Y.

1904. *AMERICAN BUREAU OF INSPECTION AND TESTS. E. B. Wilson, Secretary and Treasurer, 930 Monadnock Block, Chicago, Ill.

1906. AMERICAN BUREAU OF SHIPPING. Joseph E. Borden, Chief Engineer, 66 Beaver Street, New York, N. Y.

1910. AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION. Norman Litchfield, Secretary-Treasurer, Ninety-eighth Street and Third Avenue, New York, N. Y.

1898. *AMERICAN FOUNDRYMEN'S ASSOCIATION. Richard Moldenke, Secretary, Watchung, N. J.

1905. *AMERICAN IRON AND STEEL MANUFACTURING COMPANY. D. G. Scott, Secretary, Lebanon, Pa.

1911. AMERICAN LOCOMOTIVE COMPANY. F. J. Cole, Chief Consulting Engineer, Schenectady, N. Y.

1910. *AMERICAN RAILWAY ASSOCIATION. W. F. Allen, General Secretary, 24 Park Place, New York, N. Y.

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ELECTED.

1900. AMERICAN STEEL AND WIRE COMPANY. F. H. Daniels, Chief Engincer, Worcester, Mass.

1906. AMERICAN STEEL FOUNDRIES. J. C. Davis, Assistant First Vice-President, Chicago, Ill.

1910. *AMERICAN TELEPHONE AND TELEGRAPH COMPANY, ENGINEERING DEPARTMENT. J. J. Carty, Chief Engineer, 15 Dey Street, New York, N. Y.

1909. AMERICAN WATER WORKS AND GUARANTEE COMPANY. Herbert F. Barnard, Purchasing Agent, 345 Fourth Avenue, Pittsburg, Pa.

1906. *ANACONDA COPPER MINING COMPANY. E. P. Mathewson, Manager, Reduction Works, Anaconda, Mont.

1909. ‡ANDERSON, ABEL O. Mining and Civil Engineer, Iowa State College, Ames, Iowa.

1905. *ANDERSON, HAROLD BENTLEY. Mechanical Engineer, The Winton Motor Carriage Company, Cleveland, O.

1910. *ANDREWS AND COMPANY, F. M. Architects. W. N. Elbert, Secretary, Metropolitan Tower, 1 Madison Avenue, New York, N. Y.

1904. ANGUS, W. F. Engineer, Montreal Steel Works, Limited, Montreal, Canada.

ANTHONY, GARDNER C. (see *Tufts College, Department of Engineering*).

1906. ANTISELL, FRANK L. Constructing Engineer, Raritan Copper Works, Perth Amboy; N. J.

1909. ARMSTRONG, W. M. Vice-President, F. A. Goodrich Iron and Steel Company, Chemical Building, St. Louis, Mo.

1911. ARMSTRONG, T. P. Sales Agent, The Rail-Joint Company, 185 Madison Avenue, New York, N. Y.

1909. ‡ARNOLD, R. H. Engineer, 245 Park Avenue, W., Mansfield, O.

1910. *‡ARTER, WILLIAM D. Assistant Engineer, New York Central and Hudson River Railroad, 1012 Grand Central Station, New York, N. Y.

1906. ASHBRIDGE, RICHARD I. D. Chief Engineer, New Jersey Short Line Railroad, 605 Land Title Building, Philadelphia, Pa.

1908. ASHBY, E. B. Chief Engineer, Lehigh Valley Railroad, 143 Liberty Street, New York, N. Y.

1908. *ATKINSON, JOHN B. President, St. Bernard Mining Company, Earlington, Ky.

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ELECTED.

1907. *ATWOOD, J. A. Chief Engineer, Pittsburg and Lake Erie Railroad, Pittsburg, Pa.

1911. ATWOOD, P. H. Manager, Armstrong Cement Works, Armstrong, Iowa.

1910. AUPPERLE, J. A. Metallurgical Engineer, American Rolling Mill Company, Middletown, O.

1908. *‡AUSTILL, H., JR. Assistant Engineer, M. & O. R. R., Mobile, Ala.

BABCOCK, W. S. (see *Barrett Manufacturing Company*).

1907. BACHMAN, LLEWELLYN T. Directing Chemist, Santa Cruz Portland Cement Company, 65 Third Street, Beach Hill, Santa Cruz, Cal.

1909. *BACKERT, A. O. Editor, *The Foundry*, Browning Building, Cleveland, O.

1910. *‡BACON, CHARLES V. Analytical and Consulting Chemist, 136 Liberty Street, New York, N. Y.

1908. BACON, F. T. H. Chief Engineer, Hudson Terminals, 42 Cortlandt Street, New York, N. Y.

1908. BAILEY, E. G. Mechanical Engineer, Fuel Testing Company, 220 Devonshire Street, Boston, Mass.

BAILEY, JAMES B. (see *Central Iron and Steel Company*).

BAILEY, JOHN M. (see *Pittsburg Testing Laboratory*).

BAIN, H. F. (see *State Geological Survey*).

1909. BAIRD, HOWARD C. Principal Assistant Engineer, Boller and Hodge, 149 Broadway, New York, N. Y.

1903. BAKENHUS, R. E. Civil Engineer, United States Navy, care of W. F. Rogers, Loan and Trust Building, Washington, D. C.

1909. ‡BAKER, A. A. Assistant Civil Engineer, United States Naval Training Station, North Chicago, Ill.

BALDWIN, C. C. (see *Standard Underground Cable Company*).

1911. BALDWIN LOCOMOTIVE WORKS. H. V. Wille, Assistant to General Superintendent, 500 North Broad Street, Philadelphia, Pa.

1907. BALLENTINE, WILLIAM I. Superintendent, Link-Belt Company, Indianapolis, Ind.

BALLORD, FRED W. (see *Cleveland Engineering Society*).

1904. *BARBER ASPHALT PAVING COMPANY. J. L. Rake, General Agent, Land Title Building, Philadelphia, Pa.

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ELECTED.

1910. *‡BARBEY, JACOB W. Assistant Chemist, Packard Motor Car Company, 1180 Jos Campan Avenue, Detroit, Mich.

1898. BARBOUR, FRANK A. Civil Engineer, Snow and Barbour, 1121 Tremont Building, Boston, Mass.

BARINGER, F. J. (see *Eagle White Lead Company*).

1909. ‡BARKER, PERRY. Chemical Engineer, 93 Broad Street, Boston, Mass.

1909. *BARKSDALE, H. M. Vice-President, E. I. duPont de Nemours Powder Company, Wilmington, Del.

1910. *BARLOW, WILLIAM EDWARD. Professor of Metallurgy and Metallography, and Dean of Graduate Department, Virginia Polytechnic Institute, Blacksburg, Va.

BARNARD, HERBERT F. (see *American Water Works and Guarantee Company*).

1910. ‡BARNES, H. C. Engineer of Tests, R. D. Nuttall Company, Pittsburg, Pa.

1905. BARRETT MANUFACTURING COMPANY. W. S. Babcock, 17 Battery Place, New York, N. Y.

1908. BARTLETT, HAYWARD AND COMPANY. Founders and Engineers, Baltimore, Md.

1911. *BASSETT, S. H. President and General Manager, Knickerbocker Portland Cement Company, 1 Madison Avenue, New York, N. Y.

BASSETT, WILLIAM H. (see *American Brass Company*).

1903. BATEMAN, F. W. Civil Engineer, Clinton, Mass.

1908. BATEMAN, T. J. Chief Inspector of Steel, Delaware, Lackawanna and Western Railroad, Park Row and Sixth Street, Ambridge, Pa.

1910. BATES, P. H. Chemist, United States Geological Survey, Fortieth and Butler Streets, Pittsburg, Pa.

1911. ‡BATT, W. L. Head of Experimental Department, Hess-Bright Manufacturing Company, Twenty-first Street and Fairmount Avenue, Philadelphia, Pa.

1910. BAUSCH AND LOMB OPTICAL COMPANY. H. E. Howe, Chemist, Rochester, N. Y.

1907. *BAXTER, FLORUS R. Chief of Testing Laboratory, Vacuum Oil Company, 926 Exchange Street, Rochester, N. Y.

1911. BEACH, WILLIAM N. President, Pennsylvania Cement Company, 29 Broadway, New York, N. Y.

1906. BEALE, A. H. District Manager, American Sheet and Tin Plate Company, Vandergrift, Pa.

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ELECTED.

1908. BEALE, HORACE A., JR. President, Parkesburg Iron Company, Parkesburg, Pa.

1911. *BEALL, F. F. Factory Manager, Packard Motor Car Company, 222 Putnam Avenue, Detroit, Mich.

1904. BECK, WESLEY J. Superintendent, Electrical Department, American Rolling Mill Company, Middletown, O.

1903. BECKETT, JAMES A. Hoosick Falls, N. Y

1907. BECKSTRAND, E. H. Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah.

1908. BEEBE, LAURENCE L. Bureau of Standards, Washington, D. C.

BEEGLE, F. N. (see *Union Drawn Steel Company*).

BEGGS, JOHN I. (see *Milwaukee Electric Railway and Light Company*).

1906. BELDEN, A. W. Care of Fuel Testing Plant, Fortieth and Butler Streets, Pittsburg, Pa.

1910. ‡BELL, A. L. Box 218, Wheeling, W. Va.

1907. BENT, H. B. Engineer of Tests, Pennsylvania Steel Company, Steelton, Pa.

1910. ‡BERDON, ALBERT E. Assistant Manager, The Esterline Company, Lafayette, Ind.

1902. *BERGER, BERNT. Civil Engineer, Assistant Engineer to Theodore Cooper, 45 Broadway, New York, N. Y.

1904. *BERGQUIST, J. G. Superintendent, Cement Plant, Illinois Steel Company, Chicago, Ill.

1903. BERRALL, JAMES. Civil Engineer, Bond Building, Washington, D. C.

1910. BERRY BROTHERS, LIMITED. James S. Stevenson, Vice-President, Detroit, Mich.

1905. BERRY, H. C. Assistant Professor of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

BERRYMAN, JOHN B. (see *Crane Company*).

1910. BESTOR, FRANK C. Manager, Tar Products Department, The Kettle River Company, 954 Security Bank Building, Minneapolis, Minn.

1898. BETHLEHEM STEEL COMPANY. E. O'C. Acker, South Bethlehem, Pa.

BICKLEY, WALTER S. (see *Penn Steel Castings and Machine Company*).

1911. BINGHAM, L. L. Manager, Cement Products Company, Estherville, Iowa.

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ELECTED.

1904. BIRD, ROBERT M. Superintendent, Treatment Department, Bethlehem Steel Company, 433 Brodhead Avenue, South Bethlehem, Pa.

BIRD, WILLIAM W. (see *Worcester Polytechnic Institute*).

1905. BIRKINBINE, JOHN. Consulting Engineer, Odd Fellows' Temple, Philadelphia, Pa.

1906. BISHOP COMPANY, J. W. 109 Foster Street, Worcester, Mass.

1908. BIXBY, A. S. Superintendent, National Malleable Castings Company, Indianapolis, Ind.

1903. *BIXBY, W. H. Brigadier-General, Chief of Engineers, United States Army, 508 Colorado Building, Washington, D. C.

1904 BLACK, ADOLPH. Instructor in Civil Engineering, Columbia University, New York, N. Y.

1910. BLAIR, WILL P. Secretary, National Paving Brick Manufacturers' Association, 521 Board of Trade Building, Indianapolis, Ind.

1908. ‡BLAKELEY, ABRAHAM G. Chemist, Philadelphia and Reading Coal and Iron Company, Pottsville, Pa.

1908. *BLANCHARD, ARTHUR H. Associate Professor of Civil Engineering, Brown University; Consulting Highway Engineer; 171 Westminster Street, Providence, R. I.

1905. BLAUVELT, W. H. Consulting Engineer, Semet-Solvay Company, Syracuse, N. Y.

1909. *BLEININGER, A. V. 910 W. Nevada Street, Urbana, Ill.

1902. BLISS, COLLINS P. Professor of Mechanical Engineering and Director of Testing Laboratory, New York University, University Heights, New York, N. Y.

1909. *BLUM, A. C. Secretary and General Sales Agent, Keystone Powder Manufacturing Company, Emporium, Pa.

1910. BLUMGARDT, I. E. 5 Woodcourt, Tarrytown, N. Y.

1910. *BOARDMAN, HAROLD S. Dean of the College of Technology and Professor of Civil Engineering, University of Maine, Orono, Me.

1910. BODWELL, H. L. Assistant District Manager, American Sheet and Tin Plate Company, Vandegrift, Pa.

1905. BOLE, WILLIAM A. Manager of Works, Westinghouse Machine Company, East Pittsburg, Pa.

1903. *BOLLER AND HODGE. Consulting Engineers, 149 Broadway, New York, N. Y.

1911. BOLLING, RANDOLPH. Chemist, United States Navy Yard Norfolk, Va.

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ELECTED.

1902. BONZANO, A. President, Bonzano Rail-Joint Company, 331 South Eighteenth Street, Philadelphia, Pa.

1896. BOOTH, GARRETT AND BLAIR. Engineers and Chemists, 406 Locust Street, Philadelphia, Pa.

BORDEN, JOSEPH E. (see *American Bureau of Shipping*).

BORTON, G. W. (see *Pennsylvania Crusher Company*).

1910. BOSTON ELEVATED RAILWAY COMPANY. Paul Winsor, Chief Engineer, Motive Power and Rolling Stock, 101 Milk Street, Boston, Mass.

1904. *BOSTWICK, W. A. (*Member of Executive Committee*). Vice-President, Orford Copper Company, 43 Exchange Place, New York, N. Y.

1911. ‡BOUGHTON, EVERETT W. Assistant Chemist, Bureau of Chemistry, United States Department of Agriculture, Washington, D. C.

1911. *‡BOURG, JOSEPH N. Metallurgist, Brown-Lipe-Chapin Company, Syracuse, N. Y.

1908. BOWEN, SAMUEL B. Pecora Paint Company, Fourth and Venango Streets, Philadelphia, Pa.

1904. *BOWMAN, AUSTIN LORD. Consulting Engineer, 165 Broadway, New York, N. Y.

1911. *BOWMAN, L. H. Special Engineer, Carnegie Steel Company, Carnegie Building, Pittsburg, Pa.

1909. ‡BOYLE, JAMES J. Chemical Engineer, Box 293, Ambridge, Pa.

1907. *BOYLSTON, H. M. Instructor in Metallurgy and Metallography, Harvard University, Rotch Building, Cambridge, Mass.

1902. *BOYNTON, C. W. Inspecting Engineer, Universal Portland Cement Company, Commercial Bank Building, Chicago, Ill.

1907. BOYNTON, HENRY C. Metallurgist, John A. Roebling's Sons Company, Trenton, N. J.

1910. BRADLEY AND VROOMAN COMPANY. F. F. Bradley, Chemist, 2629 Dearborn Street, Chicago, Ill.

BRADLEY, F. F. (see *Bradley and Vrooman Company*).

1909. BRADY, WILLIAM. Chief Chemist and Chemical Engineer, Illinois Steel Company, 7642 Marquette Avenue, Chicago, Ill.

1910. ‡BRAGG, C. T. Chemical Engineer, Berry Brothers, Limited, Detroit, Mich.

1909. *BRAINARD, OWEN. Architectural Engineer, 225 Fifth Avenue, New York, N. Y.

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ELECTED.

1900. BRAINE, L. F. Vice-President, The Rail-Joint Company, 29 West Thirty-fourth Street, New York, N. Y.

1898. BRAMWELL, JOSEPH W. 4931 Rubicam Avenue, Germantown, Philadelphia, Pa.

1906. BRAZER, G. HERBERT. Civil Engineer, J. R. Worcester and Company, 79 Milk Street, Boston, Mass.

BRECKENRIDGE, L. P. (see *Sheffield Scientific School Library*).

1904. BREGOWSKY, IVAN M. Metallurgist, Crane Company, 51 Judd Street, Chicago, Ill.

1910. BRICK, EDWARD G. Manager, Springfield Contractors' Supply Company, Springfield, Mass.

BRIDGMAN, JOHN C. (see *Hazard Manufacturing Company*)

1911. *BRIDGEPORT BRASS COMPANY. Charles Ferry, Metallurgist, Bridgeport, Conn.

1906. *BRIGHT, H. DE H. Manager, Spring Department, Standard Steel Works Company, Morris Building, Philadelphia, Pa.

1899. BROADHURST, W. H. Chemist, Department of Public Works, Municipal Building, Brooklyn, N. Y.

1909. *BROBSTON, JOSEPH. Treasurer, Dexter Portland Cement Company, Nazareth, Pa.

BROWN, ALEXANDER E. (see *Brown Hoisting Machinery Company*).

1911. BROWN, ALEXANDER M. General Manager, Zug Iron and Steel Company, Box 1053, Pittsburg, Pa.

1905. BROWN AND COMPANY, INCORPORATED. Wayne Iron and Steel Works. James Neale, Secretary, Pittsburg, Pa.

1911. *BROWN AND SHARPE MANUFACTURING COMPANY. Luther D. Burlingame, Providence, R. I.

1908. BROWN, E. Assistant Professor of Applied Mechanics, McGill University, Montreal, Canada.

1911. BROWN, EDWIN H. Hewitt and Brown, Architects, 716 Fourth Avenue, South Minneapolis, Minn.

1906. BROWN HOISTING MACHINERY COMPANY, THE. Alexander E. Brown, Vice-President and General Manager, Cleveland, O.

1904. *BROWN, JOHN G. 5217 Spruce Street, Philadelphia, Pa.

1906. ‡BROWN, RICHARD P. 311 Walnut Street, Philadelphia, Pa.

1908. BROWN UNIVERSITY, DEPARTMENT OF MECHANICAL ENGINEERING. William H. Kenerson, Associate Professor of Mechanical Engineering, Providence, R. I.

1910. ‡BROWNE, FRANK A. Box 218, Wheeling, W. Va.

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ELECTED.

1903. BRUNNER, JOHN. Assistant General Superintendent, North Works, Illinois Steel Company, Chicago, Ill.

BRYAN, C. W. (see *American Bridge Company*).

1911. BRYDON, R. T. Vice-President, Wadsworth-Howland Company, 225 North Carpenter Street, Chicago, Ill.

1910. BUCH, N. W. Superintendent, Safety Armorite Conduit Company, West Pittsburg, Pa.

1909. BUCK, D. M. Chief Chemist, American Sheet and Tin Plate Company, McKeesport, Pa.

1909. *‡BUCK, LUCIEN. Civil and Consulting Engineer, Canton, N. C.

1905. BUCK, R. S. Sanderson and Porter, 52 William Street, New York, N. Y.

1903. BUCKLEY, E. R. Mining Geologist, Rolla, Mo.

1910. BUFFALO, ROCHESTER AND PITTSBURG RAILWAY COMPANY. H. F. Burnham, Chemist and Engineer of Tests, DuBois, Pa.

1908. *BULL, R. A. General Superintendent, Commonwealth Steel Company, Granite City, Ill.

1908. BULLITT, W. C. Coal Merchant, Arcade Building, Philadelphia, Pa.

1904. *BUNNELL, F. O. Engineer of Tests, Chicago, Rock Island and Pacific Railway, Chicago, Ill.

1902. BURDETT, F. A. Consulting Engineer, 29 West Thirty-fourth Street, New York, N. Y.

1910. BUREAU OF SCIENCE. Miss Mary Polk, Librarian, Manila, P. I.

1910. *BURGESS AND LONG. Hydraulic and Chemical Engineers, 827 Columbia Savings and Trust Building, Columbus, O.

1910. BURGESS, CHARLES F. Professor of Chemical Engineering, University of Wisconsin, Madison, Wis.

BURLINGAME, LUTHER D. (see *Browne and Thorpe Manufacturing Company*).

1906. BURNAP, ARTHUR M. Room 403, Wood Building, 400 Chestnut Street, Philadelphia, Pa.

BURNHAM, H. F. (see *Buffalo, Rochester and Pittsburg Railway Company*).

1899. *BURR, WILLIAM H. Professor of Civil Engineering, Columbia University, New York, N. Y.

1908. BURROWS, CHARLES W. Assistant Physicist, Bureau of Standards, Washington, D. C.

1908. BUSH, B. F. President, Davis Coal and Coke Company, Continental Building, Baltimore, Md.

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ELECTED.

1906. *BUSH, HAROLD M. Mechanical Engineer, 508 Capitol Trust Building, Columbus, O.

1908. BUSHNELL, FRED N. Mechanical Engineer, 147 Milk Street, Boston, Mass.

1905. BUSS, EDWARD A. Consulting Engineer, 85 Water Street, Boston, Mass.

1910. BUTLER, GEORGE. Master Painter, 1640 Market Street, Philadelphia, Pa.

1903. *BUZZI, P. D. Jefe del Laboratorio de Obras Publicas, Arsenal, Havana, Cuba.

CALDWELL, JAMES H. (see *Ludlow Valve Manufacturing Company*).

1911. CALIFORNIA CORRUGATED CULVERT COMPANY. H. W. Force, Secretary and Manager, West Berkeley, Cal.

1899. *CAMBRIA STEEL COMPANY. George E. Thackray, Structural Engineer, Johnstown, Pa.

1911. *CAMDEN FORGE COMPANY. W. D. Kerlin, Treasurer, Camden, N. J.

1910. CAMP, J. M. Chairman, Chemists' Committee, United States Steel Corporation, Duquesne, Pa.

CAMP, W. M. (see *Railway and Engineering Review*).

1907. ‡CAMPBELL, CHARLES M. 128 Garvine Avenue, Elyria, O.

1911. CAMPBELL GLASS AND PAINT COMPANY. F. A. Lane, General Superintendent, St. Louis, Mo.

1908. *CAMPBELL, H. H. Metallurgical Engineer, The Pennsylvania Steel Company, Morris Building, Philadelphia, Pa.

1903. *CAMPBELL, WILLIAM. Adjunct Professor of Metallography, School of Mines, Columbia University, New York, N. Y.

1906. CANALS, I. A. Civil Engineer, Box 436, San Juan, Porto Rico.

1898. *CAPP, JOHN A. Engineer, Testing Laboratory, General Electric Company, Schenectady, N. Y.

1910. *CARD, W. J. Cement Inspector, United States Reclamation Service, Hazen, Nevada.

CARHART, P. E. (see *Illinois Steel Company*).

1906. CARMODY, JOHN M. Inspector, R. W. Hunt and Company, The Rookery, Chicago, Ill.

1908. CARNAHAN, R. B., JR. General Superintendent, American Rolling Mill Company, Middletown, O.

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ELECTED.

1910. *CARNEGIE, ANDREW. 2 East Ninety-first Street, New York, N. Y.

1911. *CARNEGIE INSTITUTE, THE CIVIL ENGINEERING DEPARTMENT OF THE SCHOOL OF APPLIED SCIENCES. Michael McCullough, Assistant Professor of Materials, Pittsburg, Pa.

1908. *CARNEGIE LIBRARY. Schenley Park, Pittsburg, Pa.

1911. CARNEGIE LIBRARY, PENNSYLVANIA STATE COLLEGE. E. W. Runkle, Librarian, State College, Pa.

1898. CARNEGIE STEEL COMPANY. C. F. W. Rys, Metallurgical Engineer, Pittsburg, Pa.

1903. *CARNEY, F. D. Assistant Superintendent, The Pennsylvania Steel Company, Steelton, Pa.

CARPENTER, A. W. (see *New York Central and Hudson River Railroad Company, Engineering Department*).

1902. CARPENTER, LOUIS G. Professor of Civil and Irrigation Engineering, and Director of Experiment Station, State Agricultural College, Fort Collins, Colo.

1895. CARPENTER, ROLLA C. Professor of Experimental Engineering, Cornell University, 31 Eddy Street, Ithaca, N. Y.

1903. *†CARPENTER STEEL COMPANY, THE. J. H. Parker, Metallurgist, Reading, Pa.

1907. CARPENTER, WILLIAM M. Vice-President, Walworth and Neville Manufacturing Company, 1505 Heyworth Building, Chicago, Ill.

1903. CARTLIDGE, C. H. Bridge Engineer, Chicago, Burlington and Quincy Railroad, 209 Adams Street, Chicago, Ill.

CARTY, J. J. (see *American Telephone and Telegraph Company, Engineering Department*).

1906. CASE SCHOOL OF APPLIED SCIENCE, DEPARTMENT OF CIVIL ENGINEERING. F. H. Neff, Professor of Civil Engineering, Cleveland, O.

1908. *CATHCART, ROBERT. Specialist on Concrete Coatings, Glidden Varnish Company, Cleveland, O. *For Mail:* 2247 East Ninety-third Street, Cleveland, O.

1910. *CEMENTOS HIDALGO, S. A. Manufacturers of Cement, Hidalgo, N. L., Mexico.

1902. *CENTRAL IRON AND STEEL COMPANY. James B. Bailey, Treasurer and General Manager, Harrisburg, Pa.

1911. CHAMBERLAIN, G. D. Chief Chemist, Carnegie Steel Company, Braddock, Pa.

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ELECTED.

1910. CHAMBERLIN, A. B. Manager, Road Fuel Oil Department, Indian Refining Company, 17 Battery Place, New York, N. Y.

1905. CHAMPION, E. C. Superintendent, New York and New England Cement and Lime Company, 6 West Court Street, Hudson, N. Y.

1907. CHANDLER, B. L. Treasurer, Beckwith-Chandler Company, 201 Emmett Street, Newark, N. J.

CHAPMAN, C. M. (see *Westinghouse, Church, Kerr and Company*).

1907. CHARLS, G. H. Assistant Secretary, The American Rolling Mill Company, Middletown, O.

CHASE, NATHAN A. (see *Remington Arms and Ammunition Company*).

1911. CHATBURN, GEORGE R. Head Professor of Applied Mechanics, University of Nebraska, Lincoln, Neb.

1910. *‡CHATER, W. H. Department of Plant Maps, American Telephone and Telegraph Company, New York, N. Y. *For Mail:* Hotel Hastings, 197 Fulton Street, Brooklyn, N. Y.

1904. CHEESMAN, FRANK P. Cheesman and Elliot, Owners of National Paint Works, 100 William Street, New York, N. Y.

1911. ‡CHERRINGTON, FRANK W. In charge of Wood Preserving Department, Indian Refining Company, Cincinnati, O.

CHERRY, W. I. (see *United Paving Company*).

1908. CHESTER, M. E. Assistant Manager, The Goodyear Rubber Insulating Company, 105 East One Hundred and Thirty-first Street, New York, N. Y.

CHETWOOD, R. E. (see *Western Union Telegraph Company*).

1911. ‡CHILD, J. LEO. Director, Hancock Brick and Tile Company, Findlay, O.

1910. ‡CHILDS, WILL P. Designer, Rider-Lewis Motor Company, 825 West Seventh Street, Terre Haute, Ind.

1909. *‡CHILES, G. S. Motive Power Inspector, Lake Shore and Michigan Southern Railway, 944 Mars Avenue, Collinwood, O.

1907. CHRISTIE, ALEXANDER J. Engineer of Tests, American Bridge Company, Ambridge, Pa.

1910. *CHURCH, JOHN A. Mining Engineer, 15 William Street, New York, N. Y.

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ELECTED.

1907. CHURCH, SUMNER R. American Coal Products Company, 17 Battery Place, New York, N. Y.

1900. *CHURCHILL, CHARLES S. Chief Engineer, Norfolk and Western Railway, Roanoke, Va.

1909. *CHURCHWARD, ALEXANDER. Consulting Engineer, 30 Church Street, New York, N. Y.

1906. CINCINNATI CHAPTER, AMERICAN INSTITUTE OF ARCHITECTS. A. O. Elzner, Secretary, 608 Johnston Building, Cincinnati, O.

CLAMER, G. H. (see *Ajax Metal Company*).

1911. CLARK, A. T. Superintendent, Rolling Stock and Shops, United Railways and Electric Company, Baltimore, Md.

1910. *CLARK, ALLEN W. Editor, *American Paint and Oil Dealer*, 411 North Tenth Street, St. Louis, Mo.

1908. *CLARK, DYER O. Vice-President and General Manager, The Union Pacific Coal Company, Omaha, Neb.

1907. CLARK, EDWIN. Chief of Bureau of Building Inspection, 317 City Hall, Philadelphia, Pa.

1900. *CLARK, F. H. General Superintendent of Motive Power, Baltimore and Ohio Railroad, Baltimore, Md.

CLARK, G. T. (see *Stanford University*).

1910. ‡CLARK, W. T. Inspector of Materials, Chicago, Rock Island and Pacific Railroad, 10523 Amor Avenue, Cleveland, O.

1905. CLARKE, D. D. Civil Engineer, Water Board, City Hall, Portland, Ore.

1910. *CLARKE, E. A. S. President, Lackawanna Steel Company, 2 Rector Street, New York, N. Y.

1904. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY, THOMAS S. William S. Aldrich, Director, Potsdam, N. Y.

1910. ‡CLAY, T. F., JR. Material Inspector, Lake Shore and Michigan Southern Railway, Collinwood, O.

1908. CLEARFIELD CLAY WORKING COMPANY. Manufacturers of Paving Brick. R. S. Winslow, Secretary, Clearfield, Pa.

1905. CLEMENTS, FRANK O. Chemist, National Cash Register Company, Dayton, O.

1905. *CLEVELAND ENGINEERING SOCIETY, THE. Fred W. Ballord, Secretary, 413 Chamber of Commerce Building, Cleveland, O.

1904. CLIFTON, CHARLES H. First Assistant, Philadelphia Municipal Testing Laboratory, 318 City Hall, Philadelphia, Pa.

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ELECTED.

1907. CLINE, MCGARVEY. Director, Forest Products Laboratory, United States Department of Agriculture, Madison, Wis.

1911. CLUETT, SANFORD C. Vice-President and Secretary, Walter A. Wood Mowing and Reaping Machine Company, Hoosick Falls, N. Y.

1909. COBB, ERNEST B. Chemist, Standard Oil Company, 26 Broadway, New York, N. Y.

1905. COE, EDWARD K. Engineer of Highways and Bridges, St. Louis County, 205 Court House, Duluth, Minn.

1909. COE, THEODORE IRVING. Architect, 100 William Street, New York, N. Y.

1911. COGGESHALL, GEORGE W. Consulting Chemical Engineer, 17 Chestnut Street, Dedham, Mass.

1910. *COGSWELL, W. B. Vice-President, Solvay Process Company, Syracuse, N. Y.

1899. *COLBY, ALBERT LADD. Consulting Engineer, and Iron and Steel Metallurgist, 447 Lehigh Street, South Bethlehem, Pa.

1899. COLBY, J. ALLEN. Inspecting Engineer, Witherspoon Building, Philadelphia, Pa.

COLE, F. J. (see *American Locomotive Company*).

1910. COLE, WINTHROP. Mechanical Engineer, Engineering Experiment Station, United States Naval Academy, Annapolis, Md.

1900. *COLORADO FUEL AND IRON COMPANY. J. B. McKennan, Manager, Minnequa Plant, Pueblo, Colo.

1908. COLUMBIA STEEL AND SHAFTING COMPANY. William H. Martin, Superintendent of Rankin Works, Box 1595, Pittsburg, Pa.

1909. *COMEY, ARTHUR M. Director, Eastern Laboratory, Drawer 424, Chester, Pa.

1909. COMMONWEALTH-EDISON COMPANY. P. Junkenfeld, Assistant to Second Vice-President, 139 Adams Street, Chicago, Ill.

COMPTON, CHARLES H. (see *University of North Dakota*).

1910. CONARD, W. R. Inspecting Engineer, 322 High Street, Burlington, N. J.

1905. CONDIT, E. A., JR. Inspector, Continuous Rail-Joint Company, 520 Summer Street, Newark, N. J.

1900. CONDRON, T. L. Consulting Engineer, 1442 Monadnock Building, Chicago, Ill.

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ELECTED.

1904. CONLIN, FREDERICK. President, Samuel L. Moore and Sons, Elizabethport, N. J. *For Mail:* 835 Kensington Avenue, Plainfield, N. J.

1904. *CONRADSON, P. H. Chief Chemist, Galena Signal Oil Company, Franklin, Pa.

1908. CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED. Box 1167, Johannesburg, Transvaal.

1907. CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED, INTELLIGENCE DEPARTMENT. Box 1167, Johannesburg, Transvaal.

1905. CONVERSE, W. A. Directing Chemist, Dearborn Drug and Chemical Works, 227–234 Rialto Building, Chicago, Ill.

1903. COOK, EDGAR S. President, Warwick Iron and Steel Company, Pottstown, Pa.

COOK, HARRY H. (see *Titanium-Alloy Manufacturing Company*).

1910. COOK, H. E. Lieutenant, United States Navy, Inspector of Ordnance and Engineering Material, Bethlehem Steel Works, South Bethlehem, Pa.

1909. COOPER, FRED G. W. United States Naval Station, Honolulu, T. H.

1910. *COOPER, JAMES B. Superintendent, Calumet and Hecla Smelting Works, Hubbell, Mich.

1907. COOPER, WILLIAM A. Superintendent, Schuylkill Iron Works, Alan Wood Iron and Steel Company, Conshohocken, Pa.

1911. CORBETT, WILLEBY T. In charge of Rail Department, United States Steel Products Company, 30 Church Street, New York, N. Y.

1909. CORLISS, W. J. Mechanical Engineer, 119 Hyland Avenue, Jersey City, N. J.

1906. *CORNELL UNIVERSITY LIBRARY. George W. Harris, Librarian, Ithaca, N. Y.

1909. CORP, CHARLES I. Assistant Professor of Mechanical Engineering, Lawrence, Kan.

1909. *CORSE, W. M. Works Manager, Lumen Bearing Company, Sycamore and New York Central Belt Line, Buffalo, N. Y.

1910. CORSON, CHARLES E. Metallurgist, Railway Steel-Spring Company, 1818 Ligonier Street, Latrobe, Pa.

1899. *CORTHELL, E. L. Civil Engineer, North Edgemont, Mass.

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ELECTED.

1902. COSBY, SPENCER. Captain, Corps of Engineers, United States Army, care of War Department, Washington, D. C.

1908. *CRANE COMPANY. Manufacturers of Valves and Fittings. John B. Berryman, Assistant Secretary, Chicago, Ill.

1911. CRATTY, JOHN M. Chemist, United States Navy Yard, Philadelphia, Pa.

1906. CRAWFORD, D. F. General Superintendent, Motive Power, Pennsylvania Railroad Lines West, Room 1106, Union Station, Pittsburg, Pa.

1905. ‡CRAWFORD, HARRY C. Inspector, Railway Equipments, 1015 Harrison Building, Philadelphia, Pa.

1909. *CREMER, FRITZ. Metallurgist and Chemist, Marshall-Wells Hardware Company, Duluth, Minn.

1907. CROCKARD, FRANK H. Vice-President and General Manager, Tennessee Coal, Iron and Railroad Company, Woodward Building, Birmingham, Ala.

1911. CROCKER-WHEELER COMPANY. R. B. Treat, D. C. Designer, Ampere, N. J.

1908. CROCKETT, ARTHUR E. Secretary and General Manager, Standard Chain Company, Pittsburg, Pa.

1906. CROMWELL, O. C. Mechanical Engineer, Baltimore and Ohio Railroad Company, Mount Clare, Baltimore, Md.

1909. *CROSBY, W. W. Chief Engineer, Maryland Geological and Economic Survey, Maryland Roads Commission, Johns Hopkins University, Baltimore, Md.

CROSSMAN, G. (see *Western Electric Company*).

1908. CROWE AND COMPANY, F. T. 1105 A Street, Tacoma, Wash.

1904. *CROWELL, BENEDICT. Mining Engineer, 731 Williamson Building, Cleveland, O.

1904. *CUMMINGS, ROBERT A. Consulting and Contracting Engineer, Box 659, Pittsburg, Pa.

1910. *CUNTZ, WILLIAM C. General Manager and Treasurer, Goldschmidt-Thermit Company, 90 West Street, New York, N. Y.

1906. *CUSHING, W. C. Chief Engineer, Maintenance of Way, Pennsylvania Lines, Southwest System, Union Station, Pittsburg, Pa.

1904. CUSHMAN, ALLERTON S. Director, The Institute of Industrial Research, 804 Hibbs Building, Washington, D. C.

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ELECTED.

1908. ‡DALLAS, JOHN. Inspecting Engineer, 4910 North Twelfth Street, Philadelphia, Pa.

1906. DAMON, GEORGE A. Managing Engineer, The Arnold Company, Borland Building, Chicago, Ill.

DANIELS, F. H. (see *American Steel and Wire Company*).

DARKE, J. M. (see *General Electric Company, Lynn Works*).

1900. *DAVIDSON, GEORGE M. Engineer of Tests, Chicago and Northwestern Railroad, Chicago, Ill.

1907. DAVIES, GEORGE C. Pilling and Crane, 1410 Real Estate Trust Building, Philadelphia, Pa.

1910. DAVIES, J. VIPOND. Vice-President, Jacobs and Davies, Incorporated, 30 Church Street, New York, N. Y.

1904. *DAVIS, CHANDLER. Civil Engineer, 11 Broadway, New York, N. Y.

1905. DAVIS, CHARLES HENRY. South Yarmouth, Mass.

1910. *‡DAVIS, EUGENE T. 117 Trowbridge Street, Cambridge, Mass.

DAVIS, F. W., JR. (see *Detroit Graphite Company*).

DAVIS, J. C. (see *American Steel Foundries*).

1904. DAVIS, NATHAN H. President, Davis Solid Truss Brake Beam Company, Wilmington, Del.

1908. ‡DAVIS, ROLAND P. Instructor, Mechanical Hall, West Virginia University, Morgantown, W. Va.

DAVIS, WALTER S. (see *Wilhelm Company*).

1904. DAVIS, WILLIAM M. Lubrication Engineer, 93 Broad Street, Boston, Mass.

1903. *DAVIS, WILLIAM R. Chief Bridge Designer, State Engineer's Office, Albany, N. Y.

1899. *DEANS, JOHN STERLING. Chief Engineer, Phœnix Bridge Company, Phœnixville, Pa.

1910. DE BERTODANO, JUAN L. Lieutenant-Commander Engineer, Argentine Navy, care of New York Shipbuilding Company, Camden, N. J.

1906. *DECEW, J. A. Consulting Chemical Engineer, Sun Life Building, Montreal, Canada.

1911. DEEDS, EDWARD A. Vice-President, National Cash Register Company, Dayton, O.

1908. DEEMES, J. F. General Superintendent, Motive Power, New York Central Lines, 610 Grand Central Station, New York, N. Y.

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ELECTED.

1905. *DEKNIGHT, EDWARD W. President and Manager, Hydrex Felt and Engineering Company, 120 Liberty Street, New York, N. Y.

1910. DE PIERREFEU, A. DEDONS. Assistant Metallurgical Engineer, Illinois Steel Company, South Chicago, Ill.

1910. DERBY, W. A. Acting Engineer of Tests, Chicago, Burlington and Quincy Railroad, Aurora, Ill.

1902. *DERLETH, CHARLES, JR. Professor of Structural Engineering, University of California, Berkeley, Cal.

1904. *DETROIT GRAPHITE COMPANY. F. W. Davis, Jr., Second Vice-President, 141 Broadway, New York, N. Y.

1911. DETROIT TESTING LABORATORY, THE. 1111 Union Trust Building, Detroit, Mich.

1903. DEVERELL, H. F. Secretary, Otis Steel Company, Cleveland, O.

1909. DEVOE AND C. T. RAYNOLDS COMPANY, F. W. Manufacturers of Paints and Varnishes, etc. Represented by Roland Molineaux, 101 Fulton Street, New York, N. Y.

1908. DEWAR, JOHN. Master Painter, 850 North Avenue, North Side, Pittsburg, Pa.

1911. *DEWEY, BRADLEY. Chief of Research Laboratory, American Sheet and Tin Plate Company, Pittsburg, Pa.

1904. DE WYRALL, CYRIL. Chief Inspector, Interborough Rapid Transit Company, New York City. *For Mail:* Ridgefield Park, N. J.

1911. DICKEY, WALTER S. Proprietor, W. S. Dickey Clay Manufacturing Company, Kansas City, Mo.

DICKINSON, T. G. (see *Marquette Cement Manufacturing Company*).

1907. DILKS, L. C. Contracting Manager, Eastern Steel Company, 60 Broadway, New York, N. Y.

1903. *DILLER, H. E. Metallurgist, Research Laboratory, General Electric Company, Schenectady, N. Y.

1902. DIXON CRUCIBLE COMPANY, JOSEPH. Malcolm MacNaughton, Superintendent, Paint and Lubricating Department, Jersey City, N. J.

1901. *DOBLE, WILLIAM A. President, Abner Doble Company, Seventh and South Streets, San Francisco, Cal.

1910. DODGE, DAY AND ZIMMERMAN. Engineers, 608 Chestnut Street, Philadelphia, Pa.

1907. DOKE, G. E. Chief Inspector of Materials, Lake Shore and Michigan Southern Railway Company, Collinwood, O.

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ELECTED.

1904. DOMINION BRIDGE COMPANY. Phelps Johnson, Manager, Montreal, Canada.

1905. *DONOHOE, JOHN P. Vice-President and General Manager, Donohoe Coke Company, Greensburg, Pa.

1911. *DONOVAN, JOHN J. Supervising Architect, Palmer and Hornbostel, City Hall, Oakland, Cal.

DOOLITTLE, O. S. (see *Semet-Solvay Company*).

1907. DOUGHERTY, J. W. General Superintendent, Pennsylvania Steel Company, Steelton, Pa.

1909. DOUGHERTY, PROCTOR L. Inspector of Electric Light Plants, The Executive, Sixteenth and Newton Streets, Washington, D. C.

1910. DOUGLASS, JAMES. President, The Phelps-Douglass Company, 99 John Street, New York, N. Y.

1909. DOUGLASS, W. J. With William Barclay Parsons, 60 Wall Street, New York, N. Y.

1906. DOUTY, D. E. Assistant Physicist, Bureau of Standards, Washington, D. C.

1898. *DOW, ALLAN W. 24 East Twenty-first Street, New York, N. Y.

1910. DOYLE, J. S. Superintendent Car Equipment, Interborough Rapid Transit Company, Ninety-eighth Street and Third Avenue, New York, N. Y.

1909. DRAKE, BRYANT S. Chemical Engineer, 5930 Colby Street, Oakland, Cal.

1910. *DRINKER, HENRY S. President, Lehigh University, South Bethlehem, Pa.

1909. ‡DROWNE, HENRY B. Assistant Engineer, Rhode Island State Board of Public Roads, Box 3, East Side Station, Providence, R. I.

1904. DUBBS, J. A. President, Globe Asphalt Company, 405 Bakewell Building, Pittsburg, Pa.

1910. *‡DUBBS, LELAND A. Chemist, Globe Asphalt Company, 312 Tajo Building, Los Angeles, Cal.

1910. *DUCKWORTH-BOYER ENGINEERING AND INSPECTION COMPANY, LIMITED, THE. 171 St. James Street, Montreal, Canada.

1902. DUCOMB, W. C., JR. Engineer, Royersford Foundry and Machine Company, 52 North Fifth Street, Philadelphia, Pa.

1902. *DUDLEY, P. H. Consulting Engineer, Grand Central Station, New York, N. Y.

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ELECTED.

1909. DUDLEY, RAYMOND C. Representing Chicago-Cleveland Car Roofing Company, 720 Old Colony Building, Chicago, Ill.

1906. DUERR, H. O. General Manager, Diamond Stone Brick Company, Box 261, Wilmington, Del.

1909. DUKES, RICHARD G. Professor of Applied Science, Purdue University, Lafayette, Ind.

1902. DUMARY, L. HENRY. President, The Helderberg Cement Company, 38 State Street, Albany, N. Y.

1902. DUNBAR, W. O. Assistant Engineer, Testing Department, Pennsylvania Railroad, Altoona, Pa.

1909. DUNN, B. W. Lieutenant-Colonel, Ordnance Department, United States Army, 24 Park Place, New York, N. Y.

1904. DUNN, W. R. Superintendent, Vulcanite Portland Cement Company, Phillipsburg, N. J.

1905. DUNNING, HUBERT. National Lead Company, 100 William Street, New York, N. Y.

1904. DWIGHT, THEODORE. Mining Engineer, 15 Broad Street, New York, N. Y.

1907. *DYER, E. H. Secretary and Treasurer, Mound City Paint and Color Company, St. Louis, Mo.

1905. EAGLE WHITE LEAD COMPANY. F. J. Baringer, Chemist, Cincinnati, O.

1911. EASTERN HARD FIBRE COMPANY. H. A. Jackson, President, Merrimac, Mass.

1908. *ECKERSLEY, J. O. Assistant Engineer, Department of Bridges, New York City, 4269 White Plains Avenue, New York, N. Y.

1910. *EDDY, HARRISON P. Consulting Engineer, 14 Beacon Street, Boston, Mass.

1910. *EDWARDS, E. T. President and Manager, Vanadium Alloys Steel Company, Latrobe, Pa.

1910. EDWARDS, ROBERT S. Inspecting Engineer, Portland Railway Light and Power Company, 426 Railway Exchange, Portland, Ore.

1902. EDWARDS, WARRICK R. Engineer of Bridges, Baltimore and Ohio Railroad, Baltimore and Ohio Building, Baltimore, Md.

1905. *EHRENFELD, CHARLES H. Chemist, York Manufacturing Company, York, Pa.

EHRENSBERGER, EMIL (see *Krupp Company*).

EHRMAN, E. H. (see *Standard Screw Company*).

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ELECTED.

1904. *EIDLITZ, OTTO M. Civil Engineer, 489 Fifth Avenue, New York, N. Y.

1908. EISENSCHIML, OTTO. Chemist, American Linseed Company, South Chicago, Ill.

ELBERT, W. N. (see *Andrews and Company*).

1910. ‡ELDER, FLINT C. Metallurgist, American Steel and Wire Company, 5 High Street, Worcester, Mass.

1910. ELECTRICAL REVIEW AND WESTERN ELECTRICIAN. Morton G. Lloyd, Technical Editor, 507 Marquette Building, Chicago, Ill.

1909. *ELECTRICAL TESTING LABORATORIES. Clayton H. Sharp, Test Officer, Eightieth Street and East End Avenue, New York, N. Y.

1909. *ELLIOTT, ARTHUR H. Consulting Engineer-Chemist, 165 Broadway, New York, N. Y.

1908. *ELLIOTT, GEORGE K. Chief Chemist and Metallurgist, The Lunkenheimer Company, Cincinnati, O.

1910. *ELMQUIST, FREDERICK A. Railway Representative, The Sherwin-Williams Company, 50 Church Street, New York, N. Y.

1909. ELSON, HARRY E. Chemist, Masontown, Pa.

ELSTON, KATHERINE (see *University of Pittsburg*).

1910. ‡ELWOOD, W. F. Chief Chemist, Keystone Coal and Coke Company, Greensburg, Pa.

1907. ELY, EDWARD F. Architect, 32 Westminster Street, Providence, R. I.

1896. *ELY, THEODORE N. Bryn Mawr, Pa.

1908. ELZNER AND ANDERSON. Architects. Ingalls Building, Cincinnati, O.

ELZNER, A. O. (see *Cincinnati Chapter, American Institute of Architects*).

1909. *EMERSON LABORATORY, THE. Analytical and Industrial Chemists. F. W. Farrell, Chemist, 177 State Street, Springfield, Mass.

1908. *EMERY, A. H. Civil Engineer, 288 Main Street, Stamford, Conn.

1911. ‡EMLEY, WARREN E. Assistant Chemist, United States Bureau of Standards, Fortieth and Butler Streets, Pittsburg, Pa.

1898. ENGINEERING RECORD. 239 West Thirty-ninth Street, New York, N. Y.

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ELECTED.

1905. ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Elmer K. Hiles, Secretary, 2511 Oliver Building, Pittsburg, Pa.

1910. ENGLISH CERAMIC SOCIETY, THE. J. W. Mellor, Secretary, County Pottery Laboratory, Stoke-on-Trent, England.

1905. ENRIGHT, BERNARD. Director, Eastern Testing Laboratory, Allentown National Bank Building, Allentown, Pa.

1903. *ERLANDSEN, OSCAR. President, Metropolis Engineering Company, 329 Fulton Street, Jamaica, N. Y.

1903. ESTERLINE, J. WALTER. Assistant Professor of Electrical Engineering, Purdue University, Lafayette, Ind.

1910. *EUSTIS, W. E. C. Mining and Smelting, 131 State Street, Boston, Mass.

1909. EVANS, M. S. Chief Chemist, Bureau of Construction, City of Pittsburg, Center and Dithridge Streets, Pittsburg, Pa.

1906. EVANS, R. W. Treasurer, Picher Lead Company, 511 Tacoma Building, Chicago, Ill.

1904. EVANS, S. M. Manager, New York Office, Picher Lead Company, 100 William Street, New York, N. Y.

1905. EWING, W. W. Engineer, Westinghouse, Church, Kerr and Company, 10 Bridge Street, New York, N. Y.

1910. EYNON, D. L. Superintendent, Roll Department, Homestead Steel Works, Munhall, Pa.

1904. *FACKENTHAL, B. F., JR. President, Thomas Iron Company, Easton, Pa.

1908. ‡FALK, H. S. Superintendent, The Falk Company, Milwaukee, Wis.

1905. FALK, MYRON S. Consulting Engineer, 30 Church Street, New York, N. Y.

1902. FALKENAU, A. Consulting Engineer, 995 Madison Avenue, New York, N. Y.

1909. FALKENBURG AND LAUCKS. Analytical Chemists, 95 Yesler Way, Seattle, Wash.

1909. *FARMER, F. M. Engineer, Electrical Testing Laboratories, Eightieth Street and East End Avenue, New York, N. Y.

FARRELL, F. W. (see *Emerson Laboratory*).

1910. *FAY, A. G. President, Ætna Powder Company and Miami Powder Company, 143 Dearborn Street, Chicago, Ill.

1902. FAY, HENRY. Professor of Analytical Chemistry, Massachusetts Institute of Technology, Boston, Mass.

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ELECTED.

1909. *FENNELL, JAMES T. Inspector, Parker Boiler Company, 1006 Pennsylvania Building, Philadelphia, Pa.

1903. FENNER, L. M. Chemical Engineer, H. H. Franklin Manufacturing Company, 342½ Delaware Street, Syracuse, N. Y.

1910. *FERGUSON, D. M. Assistant Chief Engineer, The E-M-F Company, 253 Rosedale Court, Detroit, Mich.

1907. FERGUSON, F. W. Architect, 15 Beacon Street, Boston, Mass.

1909. FERGUSON, LEWIS R. Civil Engineer, 1330 Land Title Building, Philadelphia, Pa.

1909. FERNALD, ROBERT HEYWOOD. Professor of Mechanical Engineering, Case School of Applied Science, Cleveland, O.

1905. FERNOW, B. E. Dean, Forestry Department, University of Toronto, Toronto, Canada.

FERRY, CHARLES (see *Bridgeport Brass Company*).

1908. FETTY, I. H. Keith and Perry Building, Kansas City, Mo.

FINDLEY, A. I. (see *Iron Age*).

1911. *FINLEY, DOZIER. Chemist and Assistant Superintendent, The Paraffine Paint Company, Emeryville, Cal.

1909. FIREMAN, PETER. Manufacturing Chemist, Cosmos Club, Washington, D. C.

1910. *FIRMSTONE, F. Blast Furnace Manager, Easton, Pa.

1910. *FISHER, HENRY W. Chief Engineer, Standard Underground Cable Company, Westinghouse Building, Pittsburg, Pa.

1908. FISHER, THOMAS. General Superintendent, 305 Betz Building, Philadelphia, Pa.

1911. FISHER, WILLIAM A. General Agent, Atlantic Coast Line Railroad Company, Wilmington, N. C.

1910. FISKE, G. WALLACE. Assistant to Engineer of Tests, Atchison, Topeka and Santa Fé Railway, Topeka, Kan.

1909. *FITCH, HARRY M. 1055 Brush Street, Oakland, Cal.

1908. *FITTERER, J. C. Professor of Civil and Irrigation Engineering, University of Wyoming, Laramie, Wy.

1903. *FITZ GERALD, FRANCIS A. J. Chemical Engineer, Fitz Gerald and Bennie Laboratories, Niagara Falls, N. Y.

1911. FLAGG, SAMUEL B. Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburg, Pa.

1899. FLAGG, STANLEY G., JR. Stanley G. Flagg and Company, Nineteenth Street and Pennsylvania Avenue, Philadelphia, Pa.

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ELECTED.

1904. *FLEMING, HENRY S. Consulting Engineer, Room 116, 1 Broadway, New York, N. Y.

1911. ‡FLEMING, WILLIAM R. Chemist, 716 East Tenth Street, Newport, Ky.

FLEWELLIN, H. E. (see *Orford Copper Company*).

1910. FLOWERS, ARTHUR S. Sales Manager, Virginia Railway Supply Company, 324 Dickson Building, Norfolk, Va.

1908. *‡FLYNN, J. H., JR. Mechanical Engineer, Isthmian Canal Commission, Gorgona, Canal Zone.

1910. *FOLLANSBEE BROTHERS COMPANY. William U. Follansbee, Secretary and Treasurer, Pittsburg, Pa.

FOLLANSBEE, WILLIAM U. (see *Follansbee Brothers Company*).

1906. FOLLER, CHARLES S. Mechanical Engineer, Union Spring, Manufacturing Company, Farmers' Bank Building, Pittsburg, Pa.

1907. *FORCE, H. J. Ghemist and Engineer of Tests, Delaware, Lackawanna and Western Railroad Company, Scranton, Pa.

FORCE, H. W. (see *California Corrugated Culvert Company*).

1904. FORD, ALLEN P. Metallurgist, Eaton, Cole and Burnham Company, Bridgeport, Conn.

1911. *FORD, WILLIAM H. General Sales Manager, Canada Cement Company, Limited, Montreal, Canada.

1901. FORREST, C. N. Chief Chemist, New York Testing Laboratory, Maurer, N. J.

1909. *FORSTALL, ALFRED E. Consulting Engineer, 58 William Street, New York, N. Y.

1910. *FORSYTH, ROBERT. Consulting Engineer, 1159 The Rookery, Chicago, Ill.

1903. FORSYTH, WILLIAM. Mechanical Engineer, *Railroad Age Gazette*, Chicago, Ill.

1910. *FORT, EDWIN J. Chief Engineer of Sewers, Borough of Brooklyn, 215 Montague Street, Brooklyn, N. Y.

1910. *FOUGNER, HERMANN. Civil Engineer, 25 Madison Square, North, New York, N. Y.

1911. *FOWLER, GEORGE L. Associate Editor, *Railway Age Gazette*, 83 Fulton Street, New York, N. Y.

1905. FOX, ADAM H. President, American Equipment Company, Norristown, Pa.

1908. FRANCIS, J. RICHARD. Chemist, Cleveland, Cincinnati, Chicago and St. Louis Railway, Indianapolis, Ind.

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ELECTED.

1906. FRANK, JEROME W. Chemist, Standard Varnish Works, 29 Broadway, New York, N. Y.

1898. FRANKLIN INSTITUTE. R. B. Owens, Secretary, 15 South Seventh Street, Philadelphia, Pa.

1907. *FRANKLIN MANUFACTURING COMPANY, H. H. 400 South Geddes Street, Syracuse, N. Y.

FRANKLIN, WILLIAM B. (see *United States Cast Iron Pipe and Foundry Company*).

1905. *FREEMAN, JOHN R. Consulting Engineer, 814 Banigan Building, Providence, R. I.

1903. FRENCH, JAMES B. Bridge Engineer, Room 1276, 50 Church Street, New York, N. Y.

1911. *FRIEND, O. C. Assistant Factory Manager, Mitchell-Lewis Motor Company, Racine, Wis.

1904. FROEHLING AND ROBERTSON. Analytical Chemists, Chemical and Mining Engineers, 17 South Twelfth Street, Richmond, Va.

1909. FROHMAN, E. D. Secretary, The S. Obermayer Company, Pittsburg, Pa.

1905. *FRY, LAWFORD H. Technical Representative in Europe of the Baldwin Locomotive Works, 64 Rue de la Victoire, Paris, France.

1907. FRYE, ALBERT I. Consulting Engineer, 90 West Street New York, N. Y.

1903. *FULLER, ALMON H. Professor of Civil Engineering, Washington University, University Station, Seattle, Wash.

1906. FULLER, CHARLES E. Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

FULLER, GEORGE F. (see *Wyman and Gordon Company*).

1908. FULLER, J. W., JR. General Manager, Lehigh Car Wheel and Axle Works, Catasauqua, Pa.

1904. FULLER, WILLIAM B. Expert Engineer, Room 1135, 150 Nassau Street, New York, N. Y.

1909. *FULWEILER, W. HERBERT. Department of Tests, United Gas Improvement Company, Room 514, United Gas Improvement Building, Broad and Arch Strects, Philadelphia, Pa.

FURNESS, RADCLYFFE (see *Midvale Steel Company*).

1910. FURST, E. W. With The Grassilli Chemical Company, 784 Arcade, Cleveland, O.

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ELECTED.

1908. GADD, CHARLES J. Engineer, American Iron and Steel Manufacturing Company, Lebanon, Pa.

1905. *GAEHR, DAVID. Contracting Engineer, 950 Rockefeller Building, Cleveland, O.

1910. ‡GAGE, CLARENCE E. Draftsman, The Bucyrus Company, 357 Superior Street, Milwaukee, Wis.

1909. *GAINES, RICHARD H. Chemist, Board of Water Supply, New York City, 147 Varick Street, New York, N. Y.

1903. GALBRAITH, J. Principal, School of Practical Science, University of Toronto, Toronto, Canada.

1911. *GANNON, THOMAS J. Engineer in charge of Mechanical Division and Inspection, Department of Water Supply, Gas and Electricity, 13 Park Row, New York, N. Y.

1911. *GARDNER, HARRY. Assistant Professor of Civil Engineering, University of Kansas, Lawrence, Kan.

1908. ‡GARDNER, HENRY A. Assistant Director, The Institute of Industrial Research, 804 Hibbs Building, Washington, D. C.

1905. GARFIELD, ALEXANDER STANLEY. Chief Engineer, Cie. Francaise Thomson-Houston; Consulting Engineer, Mediterranean Thomson-Houston Company and General Electric Company. 67 Avenue De Malakoff, Paris, France.

1905. GARLINGHOUSE, F. L. Structural Engineer, Jones and Laughlin Steel Company, Glenshaw, Pa.

1909. *GARRISON, O. L. President, Big Muddy Coal and Iron Company, 912 Wainwright Building, St. Louis, Mo.

GARTLEY, W. H. (see *United Gas Improvement Company*).

1911. GATES, A. W. Secretary and General Manager, Monmouth Mining and Manufacturing Company, Monmouth, Ill.

1905. GAY, MARTIN. Assistant Engineer, Department of Bridges, New York City, 103 East One Hundred and Twenty-fifth Street, New York, N. Y.

1910. GAYLEY, JAMES. Manufacturer, 71 Broadway, New York, N. Y.

1907. GEER, WILLIAM C. Chief Chemist, B. F. Goodrich Company, Akron, O.

1908. GENERAL ELECTRIC COMPANY. J. A. Capp, Chief of Testing Laboratory, Schenectady, N. Y.

1909. GENERAL ELECTRIC COMPANY, LYNN WORKS. J. M. Darke, Chief of Testing Laboratories, West Lynn, Mass.

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ELECTED.

1911. *GENERAL MOTORS COMPANY. Tracy Lyon, Director of Production, Detroit, Mich.

1909. GEORGE, W. H. Secretary, Cowell Portland Cement Company, 95 Market Street, San Francisco, Cal.

1910. GERETY, R. M. Architectural Engineer, Department of Buildings, Chicago, Ill.

1905. *GERLACH, O. Manager, Mobile Portland Cement and Coal Company, St. Stephens, Ala.

1902. *GERSTELL, A. F. Vice-President and General Manager, Alpha Portland Cement Company, Alpha, N. J.

1906. *GIBBONEY, JAMES H. Chief Chemist, Norfolk and Western Railway Company, 414 Thirteenth Avenue, S. W., Roanoke, Va.

1902. GIBBS, A. W. General Superintendent of Motive Power, Pennsylvania Railroad, Altoona, Pa.

1902. *GIBBS, GEORGE. Chief Engineer of Electric Traction, Pennsylvania Tunnel and Terminal Railroad Company, 10 Bridge Street, New York, N. Y.

1905. GIESLER, ARTHUR. Consulting Engineer, Dayton, O.

1910. ‡GIFFORD, A. McK. Chemist, General Electric Company, Pittsfield Works, 20 Linden Street, Pittsfield, Mass.

1907. GILG, HENRY F. 1223 Island Avenue, N. S., Pittsburg, Pa.

1905. *GILL, AUGUSTUS H. Assistant Professor of Technical Analysis, Massachusetts Institute of Technology, Boston, Mass.

GILLET, H. W. (see *Aluminum Castings Company*).

1906. GINDER, WILLIAM H. H. Chemist and Engineer of Tests, Eastern Steel Company, Pottsville, Pa.

1904. *GIROUX, GUSTAVE. Inspector of Materials, Canadian Pacific Railway Company, 1101 East Craig Street, Montreal, Canada.

1904. *GLASGOW IRON COMPANY. C. B. Shoemaker, President, 603-608 Harrison Building, Philadelphia, Pa.

1909. *GLIDDEN, FRED. A. Vice-President, Glidden Varnish Company, Cleveland, O.

1909. *GLOVER, GEORGE J. General Contractor, 1111 Hibernia Building, New Orleans, La.

GODDARD, WALTER T. (see *Locke Insulator Manufacturing Company*).

1910. GOETZE, FREDERICK A. Dean of the Schools of Mines, Engineering and Chemistry, Columbia University, New York, N. Y.

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ELECTED.

1910. ‡GOLDBECK, ALBERT T. Testing Engineer, Office of Public Roads, United States Department of Agriculture, 1626 S Street, Washington, D. C.

1910. *GOLDMARK, HENRY. Designing Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1909. *GOODENOUGH, WALTER. Engineer, Stone and Webster Engineering Corporation, Boston, Mass.

1904. GOODMAN, CARLTON M. Superintendent, Security Cement and Lime Company, Security, Md.

1908. *GOODRICH, E. P. Consulting Engineer, 35 Nassau Street New York, N. Y.

GOODRICH, NATHANIEL L. (see *West Virginia University Library*).

1904. GOODSPEED, G. M. Metallurgist, National Tube Company, McKeesport, Pa.

1910. *GORMULLY, A. R. Contracting Department, United States Motor Company, 896 West End Ave., New York, N. Y.

1910. GOSS, EDWARD O. Assistant Manager, Scovill Manufacturing Company, Waterbury, Conn.

1907. GOSS, OLIVER P. M. Engineer of Timber Tests, United States Forest Service. *For Mail:* Box 112, University Station, Seattle, Wash.

1896. *GOSS, WILLIAM F. M. Dean of the Schools of Engineering, University of Illinois, Urbana, Ill.

GOULD, C. H. (see *McGill University Library*).

1908. GOULD, W. S. President, Fuel Engineering Company of New York, 59 Pearl Street, New York, N. Y.

1908. *GOWIE, WILLIAM. Box 175, Kittanning, Pa.

1911. *‡GRAF, SAMUEL HERMAN. Instructor in Mechanical Engineering, State Agricultural College, Corvallis, Ore.

1911. ‡GRANGER, L. D. Metallurgist, American Steel and Wire Company, 94 Grove Street, Worcester, Mass.

1911. GRANT, JOHN ROBERT. Consulting Civil Engineer, 503 Cotton Building, Vancouver, British Columbia, Canada.

GRAY, C. D. (see *White and Company*).

1909. GRAY, H. W. Assistant Professor of Experimental Civil Engineering, in charge of Structural and Hydraulic Laboratories, Iowa State College, Ames, Ia.

1903. *GRAY, JOHN LATHROP. Assistant Superintendent, Tide-water Oil Company, E. Twenty-second St., Bayonne, N. J.

1905. *‡GRAY, THOMAS TARVIN. Chemist, Tide-water Oil Company, East Twenty-second Street, Bayonne, N. J.

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ELECTED.

1910. GREELEY, SAMUEL A. Resident Engineer, Milwaukee Refuse Incineration Plant, City Hall, Milwaukee, Wis.

1906. *GREEN, HERBERT. Mechanical Engineer, Peoples Gas Building, Chicago, Ill.

1910. ‡GREENE, E. T. Chemist, Henry S. Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1905. GREENE, GEORGE W. Inspecting Engineer, American Bureau of Inspection and Tests, 313 Wabash Building, Pittsburg, Pa.

1904. *GREENMAN, RUSSELL S. Resident Engineer in charge of Tests, Department of State Engineering and Surveying, Albany, N. Y.

1907. *GREGG, NORRIS B. President, Mound City Paint and Color Company, St. Louis, Mo.

1911. GREGORY, ALFRED C. Engineer of Sewers, 555 Rutherford Avenue, Trenton, N. J.

1906. GREGORY, E. D. Vice-President and General Manager, Frazer Paint Company, Bedford City, Va.

1906. GREGORY, JOHN H. Rudolph Hering and John H. Gregory, Consulting Engineers, 170 Broadway, New York, N. Y.

GREGORY, W. B. (see *Tulane University, Department of Experimental Engineering*).

1909. *‡GREIFENHAGEN, EDWIN O. Architectural Engineer, Department of Buildings, City of Chicago. *For Mail:* 823 Wellington Avenue, Chicago, Ill.

1902. GREINER, J. E. Consulting Engineer, 605 Continental Building, Baltimore, Md.

1910. GRIFFITH, J. K. 303 Susquehanna Avenue, Pittston, Pa.

1906. GRIFFITH, R. E. Vice-President, American Cement Company, 604 Pennsylvania Building, Philadelphia, Pa.

1906. *GRIFFITHS, T. S. General Manager, Canadian Inspection Company, 204 St. James Street, Montreal, Canada.

1910. GROSE, JAMES H. Superintendent, Howard Axle Works, Carnegie Steel Company, Homestead, Pa.

1909. *GUDEMAN, EDWARD. Chemical Engineer, 903 Postal Telegraph Building, Chicago, Ill.

1907. GULICK, HENRY, JR. Gulick-Henderson Company, 439 Third Avenue, Pittsburg, Pa.

1908. HAAS, FRANK R. Consulting Engineer, The Consolidation Coal Company, Fairmont, W. Va.

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ELECTED.

1906. *HADFIELD, R. A. Steel Manufacturer, Hecla Works, Sheffield, England.

1901. HAGAR, EDWARD M. President, Universal Portland Cement Company, Commercial Bank Building, Chicago, Ill.

1910. HAGER, ALBERT B. Secretary, Fidelity Engineering and Inspecting Company, 30 Church Street, New York, N. Y.

1906. HAINES, JOHN L. Assistant to Vice-President, Jones and Laughlin Steel Company, Pittsburg, Pa.

1905. HALDEMAN, HORACE L. Treasurer, Pulaski Iron Company, 1008 Real Estate Trust Building, Philadelphia, Pa.

HALE, H. E. (see *Missouri Pacific Railway Company*).

1910. *HALE, RICHARD KING. Civil Engineer, 85 Water Street, Boston, Mass.

1911. HALL, CHARLES WARD. Contractor and Engineer, 140 Nassau Street, New York, N. Y.

1910. HALL, CLARENCE. Explosives Engineer, Fortieth and Butler Streets, Pittsburg, Pa.

1911. ‡HALL, ELLIS B. Chemist and Engineer of Tests, Cleveland, Cincinnati, Chicago and St. Louis Railroad, 2329 North Capitol Avenue, Indianapolis, Ind.

1910. *HALL, JOHN H. Metallurgist, Taylor Iron and Steel Company, High Bridge, N. J.

1908. HAMBURGER, SAMUEL. Assistant Engineer, Department of Bridges, City of New York, Park Row Building, New York, N. Y.

1910. *HAMMOND, GEORGE T. Engineer of Design, Bureau of Sewers, Brooklyn, 156 Berkeley Place, Brooklyn, N. Y.

1911. HAMNER, CHARLES S. Mechanical Engineer, 25 Broad Street, New York, N. Y.

1903. *HANCOCK, E. L. Professor of Applied Mechanics, Worcester Polytechnic Institute, Worcester, Mass.

1905. *HAND, ELWOOD STOKES. Special Representative, Pennsylvania Wire Glass Company, 100 Broadway, New York, N. Y.

1905. ‡HANNA, W. C. Chemist, California Portland Cement Company, Colton, Cal.

HARAHAN, J. T. (see *Illinois Central Railroad Company*).

1905. HARDING, CHESTER. Captain, Corps of Engineers, United States Army, Gatun, Canal Zone.

1902. HARDING, W. H. President, Whitehall Cement Manufacturing Company, 1722 Land Title Building, Philadelphia, Pa.

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ELECTED.

1903. *HARGROVE, JULIAN O. Inspector of Asphalt and Cements, 1603 O Street, N. W., Washington, D. C.

1902. *HARRIMAN, N. F. Chemist and Engineer of Tests, Union Pacific Railroad, Omaha, Neb.

HARRIS, GEORGE W. (see *Cornell University Library*).

1908. HARRIS, J. R. Chief Chemist, T. C. I. & R. R. Co., Box 731, Birmingham, Ala.

1910. *HARRISON, P. B. General Superintendent, Chicago Railway Equipment Company, Forty-sixth Street and Winchester Avenue, Chicago, Ill.

1902. *HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY. Francis B. Allen, Vice-President, Hartford, Conn.

1904. HARTLEY, HENRY J. Superintendent, Boiler Department, William Cramp and Sons, 1624 Oxford Street, Philadelphia, Pa.

1898. HARTRANFT CEMENT COMPANY, WILLIAM G. Sole Selling Agent for Old Dominion and Phœnix Portland Cement, Real Estate Trust Building, Philadelphia, Pa.

1905. *HARVARD COLLEGE LIBRARY. Alfred C. Potter, Assistant Librarian, Cambridge, Mass.

1911. HARVIE, WILLIAM J. Chief Engineer, Utica and Mohawk Valley Railway Company, Syracuse, N. Y.

1911. *HASTINGS, CHARLES L. General Sales Manager, Vanadium Sales Company of America, 324 Frick Building, Pittsburg, Pa.

1898. *HATT, WILLIAM K. Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

1910. HAVENS, WILLIAM W. Assistant Engineer, Public Service Commission for the First District, State of New York, 469 East One Hundred and Thirty-fourth Street, New York, N. Y.

1904. *HAWXHURST, ROBERT, JR. Consulting Engineer, 623 Salisbury House, London, E. C., England.

1906. HAYES, J. ARTHUR. Resident Manager, United States Cast Iron Pipe and Foundry Company, Burlington, N. J.

1907. HAYWARD, HENRY E. Engineer of Tests, Link-Belt Company, Nicetown, Philadelphia, Pa.

1906. HAYWARD, H. W. Instructor, Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1906. HAZARD MANUFACTURING COMPANY. John C. Bridgman, General Manager, Wilkesbarre, Pa.

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ELECTED.

1907. HAZEN, WILLIAM NELSON. Engineer, Expanded Metal Engineering Company, Union Building, Newark, N. J.

1906. HEALD, E. C. Chief Structural Engineer, Office of Supervising Architect, Treasury Department, Washington D. C.

1903. HEARNE, W. W. Member of firm Mathew Addy and Company, 1625 Real Estate Trust Building, Philadelphia, Pa.

1910. *HEATH, GEORGE L. Chemist, Calumet and Hecla Smelting Works, Hubbell, Mich.

1905. HECKEL, G. B. Editor, *Drugs, Oils and Paints*, 634–36 The Bourse, Philadelphia, Pa.

1904. HEIDENREICH, E. LEE. Special Engineer, New York Central and Hudson River Railroad, 1220 Grand Central Station, New York, N. Y.

1910. HEINRICH, E. O. City Chemist, 3214 North Thirtieth Street, Tacoma, Wash.

1910. ‡HEIZMANN, L. J. Mechanical Engineer, Penn Hardware Company, 318 North Fifth Street, Reading, Pa.

1909. HELLER AND WILSON. Consulting Engineers, First National Bank Building, San Francisco, Cal.

1904. *HELWIG, ALFRED. Engineer, Edison Electric Illuminating Company, 360 Pearl Street, Brooklyn, N. Y.

1904. *HEMSTREET, GEORGE P. Superintendent, Hastings Pavement Company, Hastings-upon-Hudson, N. Y.

HENDEE, EDWARD T. (see *Ryerson and Son*).

1910. HENDRICKS, A. B., JR. Engineer of Materials, General Electric Company, Pittsfield Works, 212 East Street, Pittsfield, Mass.

HENRY, A. S. (see *Railway Steel Spring Company*).

1911. HENRY, JOHN A. Chief Inspector, Homestead Steel Works, Carnegie Steel Company, Munhall, Pa.

1903. HENSHAW, JOHN O. Member, N. S. Bartlett and Company, 126 State Street, Boston, Mass.

HEPBURN, W. M. (see *Purdue University Library*).

1909. HEPPINSTALL, C. W. Secretary and Treasurer, Heppinstall Forge and Knife Company, Forty-seventh Street and Allegheny Valley Railway, Pittsburg, Pa.

1904. *HERING, RUDOLPH. Hydraulic and Sanitary Engineer, 170 Broadway, New York, N. Y.

1910. ‡HERMANN, CHARLES E. Assistant to President, Moose Mountain, Limited, 111 Broadway, New York, N. Y.

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ELECTED.

1911. ‡HERMANN, GEORGE E. Inspector, R. W. Hunt Company, 309 White Building, Seattle, Wash.

1910. *HERRESHOFF, JAMES B., JR. Superintendent, Nichols Copper Company, Laurel Hill, N. Y.

1911. *HERRON, JAMES H. Consulting Engineer and Metallurgist, Engineers' Building, Cleveland, O.

1906. *HERSEY, MILTON L. City and Provincial Analyst, 171 St. James Street, Montreal, Canada.

HESS, HENRY E. (see *New York Fire Insurance Exchange*).

1910. ‡HEWITT, THOMAS E. Assistant Chemist, American Sheet and Tin Plate Company, 331 Atwood Street, Pittsburg, Pa.

1910. HEYL AND PATTERSON, INCORPORATED. W. J. Patterson, President, 50 Water Street, Pittsburg, Pa.

1910. *HIBBARD, HENRY D. Consulting Engineer, 144 East Seventh Street, Plainfield, N. J.

1911. *HIBBS, MANTON E. Structural Engineer, Bureau of Building Inspection, 317 City Hall, Philadelphia, Pa.

1902. HILDRETH, P. S. Consulting and Inspecting Engineer, 135 Broadway, New York, N. Y.

HILES, ELMER K. (see *Engineers' Society of Western Pennsylvania*).

1910. HILL, C. D. Engineer, Board of Local Improvements City Hall, Chicago, Ill.

1911. HILL, HALBERT P. Engineer, 30 Church Street, New York, N. Y.

1909. HILL, NICHOLAS S., JR. Consulting Engineer, 100 William Street, New York, N. Y.

1909. HILLEBRAND, W. F. Chief Chemist, Bureau of Standards, Washington, D. C.

1909. *HILLES, RAYMOND W. Sales Manager, S. H. French and Company, York Avenue, Fourth and Callowhill Streets, Philadelphia, Pa.

1907. HINCKLEY, BENJAMIN S. Engineer of Tests, New York New Haven and Hartford Railroad Company, New Haven, Conn.

1907. HINCKLEY, J. F. Civil and Consulting Engineer, 1423 Syndicate Trust Building, St. Louis, Mo.

1906. HOBBS, F. E. Lieutenant-Colonel, commanding Rock Island Arsenal, Rock Island, Ill.

1911. HOCKSTETTER, ROBERT. Vice-President, The Ault and Wiborg Company, Cincinnati, O.

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ELECTED.

1910. HODGES, HARRISON B. Purchasing Agent and Superintendent of Tests, Long Island Railway Company, New York, N. Y.

1904. *HOFF, OLAF. Consulting Engineer, 149 Broadway, New York, N. Y.

1907. ‡HOFFHINE, JOHN. First Assistant Chemist, Union Pacific Railroad, Omaha, Neb.

1907. HOGUE, CHESTER J. Constructing Engineer, Eastern Expanded Metal Company, 101 Tremont St., Boston, Mass.

1907. *HOKANSON, MARTIN. Assistant Professor of Materials of Construction, Carnegie Technical Schools, Pittsburg, Pa.

1906. ‡HOLMES, ADDISON F. Instructor, Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1903. HOLMES, JOSEPH A. Director, Bureau of Mines, Washington, D. C.

1907. *HOLST, J. L. Engineer of Structures, New York Central and Hudson River Railroad, 335 Madison Avenue, New York, N. Y.

HOLTON, E. C. (see *Sherwin-Williams Company*).

1906. *HOOKER, A. H. Care of Development and Funding Company, Niagara Falls, N. Y.

1911. HOOVER, W. C. Secretary-Treasurer and Manager, Portland Drain Tile Company, Portland, Ind.

1911. HOPKINS, GEORGE A. Metallurgist, Carnegie Steel Company, Munhall, Pa.

1904. HOPTON, W. E. Assistant Purchasing Engineer, Solvay Process Company, Syracuse, N. Y.

1911. *HORMANN, F. W. Sales Manager, Byerly and Sons, 830 Land Title Building, Philadelphia, Pa.

1910. HORN, A. C. Waterproofing Contractor, 8–10 Burling Slip, New York, N. Y.

HORNE, H. J. (see *Roebling's Sons Company*).

1908. *HOVEY, O. E. Assistant Chief Engineer, American Bridge Company of New York, Hudson Terminal, 30 Church Street, New York, N. Y.

1904. HOW, R. W. Assistant Engineer, Long Island Railroad Company, R. D. No. 3, Perry, N. Y.

1906. HOWARD, JAMES E. Engineer-Physicist, Bureau of Standards, Washington, D. C.

1909. HOWARD, JAMES W. Consulting Engineer, 1 Broadway, New York, N. Y.

1903. HOWARD, L. E. 152 Walnut Street, Lockport, N. Y.

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ELECTED.

1909. *HOWARD, O. ZELL. Mechanical Engineer, United States Naval Experiment Station, Annapolis, Md.

HOWE, H. E. (see *Bausch and Lomb Optical Company*).

1896. *HOWE, HENRY M. (*President*). Professor of Metallurgy, Columbia University, Broad Brook Road, Bedford Hills, N. Y.

1909. HOWE, MALVERD A. Professor of Civil Engineering, Rose Polytechnic Institute, 2108 North Tenth Street, Terre Haute, Ind.

1910. HOWELL, SPENCER P. Assistant Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburg, Pa.

1909. HOXIE, FREDERICK J. Engineer and Special Inspector, Mutual Fire Insurance Company's Factory, Phenix, R. I.

1905. *HOYT METAL COMPANY. J. Clarence McGrew, Engineer of Tests, St. Louis, Mo.

1908. ‡HUBBARD, PRÉVOST. Assistant Chemist, Office of Public Roads, United States Department of Agriculture, Washington, D. C.

1904. *HUBBELL, C. A. President, R. Almond Manufacturing Company, Ashburnham, Mass.

1904. HUBER, FREDERICK W. Consulting Engineer, 202 Kerckhoff Building, Los Angeles, Cal.

1905. HUGHES AND PATTERSON. Manufacturers of Bar Iron, 800 Richmond Street, Philadelphia, Pa.

1905. *HUGHES, HECTOR J. Assistant Professor of Hydraulics and Sanitary Engineering, Harvard University, 114 Pierce Hall, Cambridge, Mass.

1907. HUGHES, L. S. Chief Chemist, Picher Lead Company, Tacoma Building, Chicago, Ill.

1904. HUME, A. P. Engineer of Tests, American Bridge Company, Pencoyd, Pa.

1896. *HUMPHREY, RICHARD L. Consulting Engineer and Chemist, 805 Harrison Building, Philadelphia, Pa.

1903. HUNNINGS, S. V. Chemist and Engineer of Tests, American Locomotive Company, Schenectady, N. Y.

1903. *HUNT, LOREN E. Bureau of Engineering, Department of Public Works, San Francisco, Cal. *For Mail:* 38 Sixth Avenue, San Francisco, Cal.

1899. *HUNT AND COMPANY, ROBERT W. Inspecting and Testing Engineers. Robert W. Hunt (*Member of Executive Committee*), 1121 The Rookery, Chicago, Ill.

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ELECTED.

1907. *HUNT COMPANY, LIMITED, ROBERT W. T. C. Irving, Jr., Vice-President, Traders' Bank Building, Toronto, Canada.

1903. HUNTER, JOSEPH W. First Deputy, State Highway Commission, Harrisburg, Pa.

1911. ‡HUNTINGTON, W. C. Metallurgist, Gary Works, Indiana Steel Company, 565 Jackson Street, Gary, Ind.

HUSTON, CHARLES L. (see *Lukens Iron and Steel Company*).

1910. HUTCHINS, H. C. Secretary, Ajax Forge Company, Hoyne Street and Blue Island Avenue, Chicago, Ill.

1906. HUTCHINSON, CARY T. Consulting Engineer, 60 Wall Street, New York, N. Y..

1905. HYDE, A. LINCOLN. Assistant Professor of Bridge Engineering, University of Missouri, Columbia, Mo.

1903. HYDE, CHARLES G. Assistant Professor of Sanitary Engineering, University of California, Berkeley, Cal.

1906. ICKES, ELWOOD T. Inspector, Carnegie Steel Company, Room 522, Carnegie Building, Pittsburg, Pa.

1904. *ILLINOIS CENTRAL RAILROAD COMPANY. J. T. Harahan, Engineer, Commercial National Bank Building, Chicago, Ill.

1900. ILLINOIS STEEL COMPANY. P. E. Carhart, Inspecting Engineer, Rookery Building, Chicago, Ill.

1906. INGALLS, F. P. Chemist, John W. Masury and Son, 15 Glenada Place, Brooklyn, N. Y.

1911. *INGBERG, S. H. Instructor in Civil Engineering, Lehigh University, 75 Church Street, Bethlehem, Pa.

1902. INTERNATIONAL ACHESON GRAPHITE COMPANY. Manufacturers of Graphite and Graphite Articles. W. Acheson Smith, Vice-President, Niagara Falls, N. Y.

1904. INTERNATIONAL HARVESTER COMPANY. John G. Wood, Second Assistant Manager, Manufacturing Department, 7 Monroe Street, Chicago, Ill.

1908. *INTERNATIONAL PAPER COMPANY. Charles F. Rhodes, Superintendent, Bureau of Tests, Glens Falls, N. Y.

1911. INTERSTATE IRON AND STEEL COMPANY. S. J. Llewellyn, President, First National Bank Building, Chicago, Ill.

1911. IRELAND, W. G. Special Representative, Jamison Coal and Coke Company, 1507 Oliver Building, Pittsburg, Pa.

1906. *IRON AGE, THE. A. I. Findley, Editor, 14 Park Place, New York, N. Y.

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ELECTED.

1902. IRON TRADE REVIEW, THE. A. O. Backert, Associate Editor, Cleveland, O.

IRVINE, FRED K. (see *Rock Products*).

IRVING, T. C., JR. (see *Robert W. Hunt Company, Limited*).

JACKSON, H. A. (see *Eastern Hard Fibre Company*).

1896. JARECKI, ALEXANDER. Superintendent, Jarecki Manufacturing Company, Limited, Erie, Pa.

1905. JEFFERS, JOHN M. Oil Inspector, National Tube Company, 1603 Jenny Lind Street, McKeesport, Pa.

1911. ‡JEFFERSON, H. F. Assistant Manager, United and Globe Rubber Manufacturing Companies, 2002 Farmers' Bank Building, Pittsburg, Pa.

1910. *JENKINS, A. LEWIS. Assistant Professor of Mechanical Engineering, University of Cincinnati, Cincinnati, O.

1909. ‡JENKINS, WESTON, JR. General Manager, Susquehanna Iron Company, Columbia, Pa.

1908. JENKS, ROBERT J. Manager, Berwind-White Coal Mining Company, 1 Broadway, New York, N. Y.

1910. *JENNINGS, ROBERT E. President, The Carpenter Steel Company, 100 Broadway, New York, N. Y.

1911. *‡JENNINGS, ROBERT EUGENE, 2ND. Assistant Superintendent, Titan Steel Casting Company, 40 Park Place, Newark, N. J.

1909. ‡JENNISON, H. C. Testing of Materials, The Coe Brass Manufacturing Company, Ansonia, Conn.

1900. *JEWETT, J. Y. Cement Expert, United States Reclamation Service, 408 Commonwealth Building, Denver, Colo.

1900. JOB, ROBERT. Vice-President, Milton Hersey Company, Limited, 171 St. James Street, Montreal, Canada.

1903. *JOHNSON, ALBERT L. Second Vice-President, Corrugated Bar Company, Bank of Commerce Building, St. Louis, Mo.

1903. JOHNSON, ARTHUR N. State Highway Engineer, Springfield, Ill.

1910. JOHNSON, CHARLES W. Assistant Manager of Works, Westinghouse Electric and Manufacturing Company, 6823 Thomas Boulevard, Pittsburg, Pa.

JOHNSON, E. V. (see *National Fireproofing Company*).

JOHNSON, J. E. (see *Lake Superior Iron and Chemical Company*).

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ELECTED.

1904. JOHNSON, J. S. A. Professor of Experimental Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

1904. JOHNSON, LEWIS J. Professor of Civil Engineering, Harvard University, 309 Pierce Hall, Cambridge, Mass

JOHNSON, PHELPS (see *Dominion Bridge Company*).

1910. ‡JOHNSON, REEVES K. Engineer of Tests, Baldwin Locomotive Works, Philadelphia, Pa.

1911. JOHNSTON, JOSEPH S. Chemist, Pressed Steel Car Company, Crafton, Pa.

1906. JOHNSTON, WILLIAM A. Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1902. *JONES AND LAUGHLIN STEEL COMPANY. Willis L. King, Vice-President, Pittsburg, Pa.

1905. *JONES, C. R. Professor of Mechanical Engineering, West Virginia University, Morgantown, W. Va.

1911. *‡JONES, H. M. Chemist, Engineering Department of Salt Lake, 504 City and County Building, Salt Lake City, Utah.

1909. JONES, JESSE L. In charge of Physical and Chemical Laboratory, Research Division, Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. *For Mail:* 612 E Street, Oakmont, Pa.

1908. JONES, JOHN H. President, The Pittsburg-Buffalo Company, 414 Frick Building, Pittsburg, Pa.

1911. ‡JONES, JOHN L. Assistant Professor of Mechanical Engineering, Oklahoma Agricultural and Mechanical College, 303 West Street, Stillwater, Okla.

1911. *JONES, MORGAN T. President, Morgan T. Jones Company, 419 Monadnock Block, Chicago, Ill.

1909. JONES, J. RAYMOND. Engineering Department, Alan Wood Iron and Steel Company, Morris Building, Philadelphia, Pa.

1908. JONES, SULLIVAN W. Architect, 63 William Street, New York, N. Y.

1908. JONSON, ERNST. Engineer Inspector, Board of Water Supply, 147 Varick Street, New York, N. Y.

1910. ‡JORDAN, HARRY E. In charge of Filtration Department, Indianapolis Water Company, 113 Monument Place, Indianapolis, Ind.

1903. JORDAN, WILLIAM, JR. Gordan Tannatt Engineering Company, Pittsburg Block, Helena, Mont.

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ELECTED.

1908. JOSIAS, HERMAN. Purchasing Agent, The Cuba Railroad, 170 Broadway, New York, N. Y.

1911. JUMPER, CHARLES H. Chemical Engineer, 18 Piquette Avenue, Detroit, Mich.

JUNKENFELD, P. (see *Commonwealth-Edison Company*).

KAELBLE, CARL (see *Technischer Verein, New York*).

1910. *KARR, C. P. 1108 Putnam Avenue, Plainfield, N. J.

1906. *KAUFMAN, GUSTAVE. Chief Engineer, The Wilson and Baillie Manufacturing Company, 26 Court Street, Brooklyn, N. Y.

1907. *KAVANAUGH, WILLIAM H. Professor of Experimental Engineering, University of Minnesota, Minneapolis, Minn.

1904. *KAY, EDGAR B. Professor of Engineering, University of Alabama, University, Ala.

1907. KAYLOR, JOHN J. Resident Mechanical Inspector, Atchison, Topeka and Sante Fé Railway, 722 Shade Avenue, Belleveu, Pa.

1906. KEARNS, W. F. 161 Devonshire Street, Boston, Mass.

1903. KEAY, H. O. Assistant Professor of Mechanical Engineering, McGill University, Montreal, Canada.

1911. ‡KEELER, WARREN I. Davenport and Keeler, 214 Main Street, New Britain, Conn.

1910. *KELLER, ARTHUR R. Professor of Civil Engineering, College of Hawaii, 1560 Magazine Street, Honolulu, T. H.

1910. KELLEY, FREDERICK W. Vice-President, Helderburg Cement Company, 78 State Street, Albany, N. Y.

1910. *‡KELSEY, VICTOR V. Chemist, Carolina, Clinchfield and Ohio Railway, Erwin, Tenn.

1908. KEMMERER, JOHN L. Coal Operator, 143 Liberty Street, New York, N. Y.

KENERSON, WILLIAM H. (see *Brown University, Department of Mechanical Engineering*).

1899. KENNEDY, FRANK G., JR. 1312 Morris Building, Philadelphia, Pa.

1904. *KENNEDY, JEREMIAH J. Consulting Engineer, 52 Broadway, New York, N. Y.

1904. *KENNEY, E. F. Metallurgical Engineer, Cambria Steel Company, Johnstown, Pa.

1906. KENNEY, LEWIS HOBART. Draftsman in charge, Manufacturing Department, Machinery Division, United States Navy Yard, Philadelphia, Pa.

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ELECTED.

1902. KENT, WILLIAM. Professor of Mechanical Engineering, 49 Union Street, Montclair, N. J.

1908. KENT, W. C. Second Vice-President, Whitehall Portland Cement Company, 1722 Land Title Building, Philadelphia, Pa.

KERLIN, W. D. (see *Camden Forge Company*).

1910. *‡KERR, C. H. Research Ceramic Chemist, Pittsburg Plate Glass Company, Creighton, Pa.

1911. KERSHAW, WILLIAM H. Engineer, Paving and Roads Division, The Texas Company, 17 Battery Place, New York, N. Y.

1911. KESSLER, J. J. President, Dielectric Manufacturing Company, 224 South Vandeventer Avenue, St. Louis, Mo.

1905. KETCHUM, MILO S. Dean of the College of Engineering, and Professor of Civil Engineering, University of Colorado, Boulder, Colo.

1908. *KEWISH, W. H. Chief Chemist, Dixie Portland Cement Company, South Pittsburg, Tenn.

1907. KIEFER, H. E. Chemist, Edison Portland Cement Company, Stewartsville, N. J.

1903. KIESEL, W. F., JR. Assistant Mechanical Engineer, Pennsylvania Railroad, Altoona, Pa.

1906. *KIMMEL, H. R. Chemist, Industrial Testing Laboratory Superior Building, Cleveland, O.

1910. KING, D. M. Major, Ordnance Department, United States Army, Rock Island Arsenal, Rock Island, Ill.

1911. *KING, GEORGE I. Chief Engineer, Middletown Car Company, Middletown, Pa. *For Mail:* Standard Steel Car Company, Butler, Pa.

KING, WILLIS L. (see *Jones and Laughlin Steel Company*).

1899. *KINKEAD, J. A. Manager of Sales, The Parkesburg Iron Company, 2601 Singer Building, New York, N. Y.

1908. *‡KINNEY, WILLIAM M. Assistant Inspecting Engineer, Universal Portland Cement Company, 522 Frick Building, Pittsburg, Pa.

1902. *KIRCHHOFF, C. Rhineland Court, 244 Riverside Drive, New York, N. Y.

1903. *KIRCHNER, PAUL A. Structural Engineer, 40 West Thirty-sixth Street, New York, N. Y.

1909. ‡KIRSCHBRAUN, LESTER. Asphalt Chemist, City of Chicago, 160 North Fifth Avenue, Chicago, Ill.

1903. *KITTREDGE, H. G. Secretary, The Kay and Ess Company, Dayton, O.

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ELECTED.

1910. ‡KLEIN, WILLIAM H. Superintendent, Concrete Mills, United Kansas Portland Cement Company, Iola, Kan.

1910. ‡KNAPPENBERGER, H. L. Chief Chemist, The Vancouver Portland Cement Company, Limited, Tod Inlet, British Columbia, Canada.

1910. KNIGHT, S. S. Assistant to President, Scullin-Gallagher Steel and Iron Company, 6700 Manchester Avenue, St. Louis, Mo.

1903. *KNIGHTON, J. A. Engineer in Charge, Queensboro Bridge, 305 East Sixtieth Street, New York, N. Y.

1906. *KNISELY, EDWARD S. Western Representative, Bethlehem Steel Company, Box 1017, Pittsburg, Pa.

1904. KNOWLES, MORRIS. Chief Engineer, Bureau of Filtration, Pittsburg, Pa.

1909. KOCH, GEORGE B. Foreman, Physical Laboratory, Pennsylvania Railroad Company, 809 Chestnut Avenue, Altoona, Pa.

1903. KOHR, D. A. Chemist, The Lowe Brothers Company, Dayton, O.

1906. *KRANZ, W. G. Superintendent, Steel Casting Works, The National Malleable Castings Company, Sharon, Pa.

1896. *KREUZPOINTNER, PAUL. Pennsylvania Railroad, Altoona, Pa.

1904. KRUPP COMPANY, FRIED. Emil Ehrensberger, Director, Essen, Germany.

1911. *KUNZ, GEORGE F. Gem Expert, Tiffany and Company, 401 Fifth Avenue, New York, N. Y.

1908. LABORATORIO CENTRAL PARA EL ENSAYO DE MATERIALES. Escuela de Ingenieros de Caminos, Canales y Puertos, Madrid, Spain.

1903. LA CHICOTTE, H. A. Engineer in Charge, Manhattan Bridge (No. 3) and Blackwell's Island Bridge (No. 4), Park Row Building, New York, N. Y.

1905. *LACKAWANNA STEEL COMPANY. Franklin E. Abbott, Inspecting Engineer, Buffalo, N. Y.

1908. LAFAYETTE COLLEGE LIBRARY. J. F. Stonecipher, Librarian, Easton, Pa.

1909. LAKE, EDWARD N. 147 Milk Street, Boston, Mass.

1910. LAKE, HENRY B. Chemical Engineer, Canadian Pacific Railway, Winnipeg, Canada.

1910. LAKE SUPERIOR IRON AND CHEMICAL COMPANY. J. E. Johnson, Jr., Manager, Ashland, Wis.

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ELECTED.

LANE, F. A. (see *Campbell Glass and Paint Company*).

1906. LANE, H. C. Chief Draftsman, Maryland Steel Company, Sparrows Point, Md.

1903. *LANE, HENRY M. Editor of *Castings* and of *Wood Craft*, Caxton Building, Cleveland, O.

LANGDON, PALMER H. (see *Metal Industry*).

1909. LANGENBACH, E. A. Stark Rolling Mill Company, Canton, O.

1899. *LANZA, GAETANO. The Monte Vista, Sixty-third and Oxford Streets, Overbrook, Philadelphia, Pa.

1904. *LARNED, E. S. Manager, United Building Materials Company, 101 Milk Street, Boston, Mass.

1903. LARSSON, C. G. E. Assistant Chief Engineer, American Bridge Company of New York, 30 Church Street, New York, N. Y.

1910. ‡LAVAL, LEON. Assistant Director, Dudelange Steel Works. *For Mail:* Care of Société Anomyme des Haute fourneaux, Grand Duche de Luxembourg, Germany.

1911. ‡LAWRIE, JAMES. Chief Chemist and Inspector of Raw Materials, The Pullman Company, 10106 Prospect Avenue, Chicago, Ill.

1907. LAWSON, THOMAS R. Associate Professor of Rational and Technical Mechanics, Rensselaer Polytechnic Institute, 99 Twelfth Street, Troy, N. Y.

LAYMAN, J. D. (see *University of Nevada Library*).

1908. LAZELL, E. W. Consulting Engineer, Charles Warner Company, 1313 West Ninth Street, Wilmington, Del.

LE CHATELIER, H. (see *Revue de Metallurgie*).

1911. *LEDOUX AND COMPANY. A. M. Smoot, Chief Chemist, 99 John Street, New York, N. Y.

1909. *LEE, ERNEST EUGENE. Assistant Electrical and Mechanical Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1911. LEECH, J. O. Inspection Department, Carnegie Steel Company, 519 Carnegie Building, Pittsburg, Pa.

1910. LEHIGH VALLEY RAILROAD COMPANY. Stewart E. Printz, Material Inspector, Packerton, Pa.

1910. LEIBFRIED, J. E. 19 North Main Street, Bethlehem, Pa.

1898. *LESLEY, ROBERT W. (*Vice-President*). President, American Cement Company, Pennsylvania Building, Philadelphia, Pa.

LEVERING, W. L. (see *Standard Asphalt and Rubber Company*).

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ELECTED.

1911. LEWIS, ARCHER W. Chief Material Inspector, Norfolk and Western Railway Company, Roanoke, Va.

1903. LEWIS, FREDERICK H. Consulting Engineer, 732 Brown Marx Building, Birmingham, Ala.

1907. LEWIS, RANSOME T. Manager, Elmira Plant, Empire Bridge Company, 412 West Clinton Street, Elmira, N. Y.

1904. *LIDGERWOOD, JOHN H., JR. Engineer, Lidgerwood Manufacturing Company, 96 Liberty Street, New York, N. Y.

LIGGETT, THOMAS, JR. (see *United States Sherardizing Company*).

1908. ‡LINCOLN, H. J. Inspector, Atchison, Topeka, and Santa Fé Railway, 407 Ross Avenue, Wilkinsburg, Pa.

1910. *LINDAU, A. E. Chief Engineer, Corrugated Bar Company, Bank of Commerce Building, St. Louis, Mo.

1909. *LINDER, OSCAR. Chief of Testing Laboratories, Western Electric Company, Hawthorne, Ill.

1911. *‡LINDEMUTH, LEWIS B. With Pennsylvania Steel Company, Steelton, Pa.

1909. *LINDHARD, P. T. Secretary, F. L. Smidth Company, 50 Church Street, New York, N. Y.

1911. *‡LINDSAY, R. W. Chemist, Pratt and Lambert, Buffalo, N. Y.

1909. *LIPSCY, THOMAS E. L. Assistant Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

LITCHFIELD, NORMAN (see *American Electric Railway Engineering Association*).

1903. *LITTLE, INCORPORATED, A. D. C. F. Woods, Secretary, 93 Broad Street, Boston, Mass.

1908. LITTLE, CHARLES N. Professor of Civil Engineering, Idaho State University, 818 Elm Street, Moscow, Idaho.

LLEWELLYN, S. J. (see *Interstate Iron and Steel Company*).

1905. LLOYD, JOHN. Banker and Coal Operator, Altoona, Pa.

LLOYD, MORTON G. (see *Electrical Review and Western Electrician*).

1903. LOBDELL, W. W. President, Lobdell Car Wheel Company, Wilmington, Del.

1902. LOBER, J. B. President, Vulcanite Portland Cement Company, Land Title Building, Philadelphia, Pa.

1909. LOCKE INSULATOR MANUFACTURING COMPANY, THE. Walker T. Goddard, Electrical Engineer, Victor, N. Y.

1908. LOCKWOOD, GREENE AND COMPANY. Architects and Engineers for Industrial Plants, 93 Federal Street, Boston, Mass.

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ELECTED.

1908. ‡LOEPSINGER, ALBERT J. Laboratory Engineer, General Fire Extinguisher Company, 41 Atlantic Avenue, Providence, R. I.

1905. *LOHMANN, H. W. Manager, James Stewart and Company, Engineers and Contractors, 302 Lincoln Trust Building, St. Louis, Mo.

1905. LONG, E. MCLEAN. Civil Engineer, Inspector of Steel, 220 Broadway, New York, N. Y.

LOUDENBECK, HARRY C. (see *Westinghouse Air Brake Company*).

1908. *LOVELL, ALFRED. Consulting Engineer, 819 Harrison Building, Philadelphia, Pa.

1910. LOW, FRANK S. Director, Experimental and Research Department, Patton Paint Company, 215-231 Lake Street, Milwaukee, Wis.

1906. LOW, WILSON H. Head Chemist, The Cudahy Packing Company, South Omaha, Neb.

1899. LOWE BROTHERS COMPANY, THE. Houston Lowe, President, Dayton, O.

LOWE, HOUSTON (see *Lowe Brothers Company*).

1900. LOWETH, CHARLES F. Chief Engineer, Chicago, Milwaukee and St. Paul Railway, 1232 Railway Exchange, Chicago, Ill.

1908. LUCAS AND COMPANY, JOHN. Leo P. Nemzek, Gibbsboro, N. J.

1909. *LUDLOW VALVE MANUFACTURING COMPANY. James H. Caldwell, Vice-President, Troy, N. Y.

1908. *LUEHRS, DANIEL M. Mechanical Engineer, McCreery Engineering Company, Toledo, O.

1905. LUKENS, ALAN N. Mechanical Engineer, Railway Steel Spring Company, 71 Broadway, New York, N. Y.

1902. *LUKENS IRON AND STEEL COMPANY. Charles L. Huston, Vice-President, Coatesville, Pa.

1906. LUM, D. W. Chief Engineer, Maintenance of Way, Southern Railway Company, Washington, D. C.

1898. *LUNDTEIGEN, ANDREAS. Chemist, Peerless Portland Cement Company, Union City, Mich.

1906. LYNCH, THOMAS. President, H. C. Frick Coke Company, Carnegie Building, Pittsburg, Pa.

1902. *LYNCH, T. D. Engineer of Material Tests, Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.

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ELECTED.

1910. *LYON, FRANK. Lieutenant-Commander, United States Navy, 50 Franklin Street, Annapolis, Md.

LYON, TRACY (see *General Motors Company*).

1910. *MACGREGOR, JAMES S. Instructor in Civil Engineering, Columbia University, New York, N. Y.

1904. *MACK, J. LATHROP. Chief Chemist, Southern States Portland Cement Company, Box 83, Rockmart, Ga.

1908. MACKAY, H. M. Associate Professor of Civil Engineering, McGill University, Montreal, Canada.

MACKENZIE, KENNETH GERARD (see *Nairn Linoleum Company*).

1895. *MACLAY, WILLIAM W. Consulting Engineer, Lee, Mass.

1910. MACNAB, S. D. Superintendent of Tests of Materials, McGill University, Montreal, Canada.

MACNAUGHTON, MALCOLM (see *Dixon Crucible Company*).

1909. MACNICHOL, CHARLES. Master Painter, 428 Tenth Street, Washington, D. C.

1902. MACPHERRAN, R. S. Chemist, Allis-Chalmers Company, West Allis Works, Milwaukee, Wis.

1910. *MAGEE, GUY, JR. Constructing Engineer, 36 Bishopsgate, London, England.

1904. MAHON, R. W. Chemist, New York Central and Hudson River Railroad, West Albany, N. Y.

1907. MAIN, WILLIAM. Consulting Engineer and Chemist, 100 Broadway, New York, N. Y.

1902. MAJOR, CHARLES. Manager, Pencoyd Iron Works, American Bridge Company, Pencoyd, Pa.

1908. MANNHARDT, HANS. Chief Chemist, Heath and Milligan Manufacturing Company, 1104 Oakdale Avenue, Chicago, Ill.

1907. MANSFIELD, ARTHUR N. 107 Woburn Street, Reading, Mass.

1898. *MARBURG, EDGAR (*Secretary-Treasurer*). Professor of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

1906. MARIS, JOHN M. Principal, School of Structural Engineering, International Correspondence Schools, Scranton, Pa.

1905. *MARQUETTE CEMENT MANUFACTURING COMPANY. T. G. Dickinson, General Manager, La Salle, Ill.

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ELECTED.

1907. MARSH, C. P. Assistant to Engineer of Structures, New York Central and Hudson River Railroad, Room 1201, 335 Madison Avenue, New York, N. Y.

1905. MARSTON, A. Dean of Division of Engineering, Iowa State College, Ames, Iowa.

1907. MARTIN, EDGAR D. Architect, 172 Washington Street, Chicago, Ill.

1902. MARTIN, SIMON S. Superintendent, Maryland Steel Company, Sparrows Point, Md.

MARTIN, WILLIAM H. (see *Columbia Steel and Shafting Company*).

1907. MARVIN, F. O. Dean, School of Engineering, University of Kansas, Lawrence, Kan.

1910. ‡MARX, PAUL W. Chief Chemist, Great Western Portland Cement Company, Box 15, Mildred, Kan.

1908. ‡MASTERS, FRANK M. Pittsburg Representative of Ralph Mojeski, 607 Arnott Building, Pittsburg, Pa.

1903. MASTERS, J. B. Inspecting Engineer, Pittsburg Representative of Hildreth and Company, 506 North St. Clair Street, Pittsburg, Pa.

1906. MASURY AND SON, JOHN W. 44 Jay Street, Brooklyn, N. Y.

1902. MATCHAM, CHARLES A. Vice-President and General Manager, Allentown Portland Cement Company, Allentown, Pa.

1911. *MATHESON, GEORGE, JR. General Manager, Spang, Chalfant and Company, Incorporated, Union Bank Building, Pittsburg, Pa.

1903. *MATHEWS, JOHN A. Operating Manager and General Superintendent, Halcomb Steel Company, Syracuse, N. Y.

MATHEWSON, E. P. (see *Anaconda Copper Mining Company*).

1904. *MAURER, E. R. Professor of Mechanics, University of Wisconsin, Madison, Wis.

1910. MCBURNEY, HENRY. Civil Engineer, 38 East Thirty-first Street, New York, N. Y.

1896. MCCAULEY, H. K. Secretary and Treasurer, Altoona Iron Company, Altoona, Pa.

1906. MCCORMACK, HARRY M. Professor of Chemical Engineering, Armour Institute of Technology, Chicago, Ill.

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ELECTED.

1905. McCREA, ARCHIBALD M. President, Union Spring and Manufacturing Company, Farmers' Bank Building, Pittsburg, Pa.

1903. *McCREADY, ERNEST B. General Manager, Lehigh Valley Testing Laboratory, Fourth and Linden Streets, Allentown, Pa.

1908. McCREATH AND SON, ANDREW S. Chemists, 121 Market Street, Harrisburg, Pa.

1909. *McCULLOCH, JOHN A. Mechanical Engineer, 1111 Park Street, McKeesport, Pa.

McCULLOUGH, MICHAEL (see *Carnegie Institute*).

1910. McDONNELL, M. E. Chemist and Bacteriologist, Pennsylvania Railroad Company, Altoona, Pa.

1907. *MACFARLAND, G. S. Chemist, The Wyman and Gordon Company, Worcester, Mass.

1903. McGILL UNIVERSITY LIBRARY. C. H. Gould, Librarian, Montreal, Canada.

1905. McGRADY, J. W. Chief Inspector, Homestead Steel Works, Carnegie Steel Company, Munhall, Pa.

McGREW, J. CLARENCE (see *Hoyt Metal Company*).

1907. McGUIRE, JAMES C. Civil Engineer, 26 Cortlandt Street, New York, N. Y.

1906. McILHINEY, PARKER C. Consulting Chemist, 7 East Forty-second Street, New York, N. Y.

1896. *McKENNA, CHARLES F. Chemist, 1553 Hudson Terminal Building, 50 Church Street, New York, N. Y.

McKENNAN, J. B. (see *Colorado Fuel and Iron Company*).

1909. ‡McKENZIE, HERMAN E. Engineer of Timber Tests, Forest Products Laboratory, Madison, Wis.

1905. McKIBBEN, FRANK P. Professor of Civil Engineering, Lehigh University, South Bethlehem, Pa.

1902. *McLEOD, JOHN. Assistant to President, Carnegie Steel Company, Pittsburg, Pa.

1909. McLURE, NORMAN R. Resident Engineer, Phœnix Bridge Company and Phœnix Iron Company, 527 Pierce Building, St. Louis, Mo.

1911. *McMASTER, H. B. Commissioner, Association of Metal Lath Manufacturers of the United States, 812 Wick Building, Youngstown, O.

1904. *McNAUGHER, D. W. Civil Engineer, Monongahela Bank Building, Pittsburg, Pa.

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ELECTED.

1907. McNAUGHTON, J. P. General Sales Agent, Dominion Iron and Steel Company, Sydney, Nova Scotia, Canada.

1904. *MEAD, CHARLES ADRIANCE. Engineer of Bridges, Board of Railroad Commissioners of the State of New Jersey, 165 Wildwood Avenue, Upper Montclair, N. J.

1899. MEADE, RICHARD K. General Manager, Tidewater Portland Cement Company, 807 Keyser Building, Baltimore, Md.

1902. MEIER, E. D. President and Chief Engineer, Heine Safety Boiler Company, 11 Broadway, New York, N. Y.

MELLOR, J. W. (see *English Ceramic Company*).

1910. *MERIWETHER, COLEMAN. President and Chief Engineer, Lock Joint Pipe Company, 165 Broadway, New York, N. Y.

1909. MERRILL, O. C. Hydraulic and Sanitary Engineer, 3008 Benvenue Avenue, Berkeley, Cal.

1895. *MERRIMAN, MANSFIELD (*Past President*). Consulting Engineer, 1071 Madison Avenue, New York, N. Y.

1909. *METAL INDUSTRY, THE. Palmer H. Langdon, Editor and Publisher, 61 Beekman Street, New York, N. Y.

1910. *MICHAELIS, W., JR. Consulting Engineer for the *Cement Industry*, Schiller Building, Chicago, Ill.

1909. *MIDVALE STEEL COMPANY. Radclyffe Furness, Engineer in charge of Research, Philadelphia, Pa.

1910. MILES, JOHN B. Member of Firm, Frank C. Roberts and Company, Real Estate Trust Building, Philadelphia, Pa.

1903. MILLER, RUDOLPH P. Superintendent of Buildings, Borough of Manhattan, 220 Fourth Avenue, New York, N. Y.

MILLER, W. I. (see *Pittsburg Forge and Iron Company*).

1900. MILLS, CHARLES M. Consulting Engineer, 4813 Beaumont Avenue, Philadelphia, Pa.

1910. *MILLS, JAMES W. Chief Chemist, National Enameling and Stamping Company, Granite City, Ill.

1910. *MILLWOOD, JAMES P. Chemist, United States Navy Yard, 246 Willoughby Avenue, Brooklyn, N. Y.

1909. *MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY. John I. Beggs, President and General Manager, Milwaukee, Wis.

1910. *MISSOURI PACIFIC RAILWAY COMPANY. H. E. Hale, Engineer of Design, St. Louis, Mo.

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ELECTED.

1907. MITCHELL, A. E. Vice-President, The Wychoff Pipe and Creosoting Company, Incorporated, 50 Church Street, New York, N. Y.

1907. MITCHELL, ROBERT. General Sales Agent, Pennsylvania, Beech Creek and Eastern Coal Company, Land Title Building, Philadelphia, Pa.

1903. *MOISSEIFF, LEON S. Assistant Engineer to Commissioner of Bridges, 13 Park Row, New York, N. Y.

1896. *MOLDENKE, RICHARD (*Member of Executive Committee*). Metallurgist, Consulting Engineer, Watchung, N. J.

MOLINEAUX, ROLAND (see *Devoe and Raynolds Company*).

1908. MOLLESON, GEORGE E. Manager, Railroad Department, Tyler Tube and Pipe Company, 50 Church Street, New York, N. Y.

1906. MONTANA COLLEGE OF AGRICULTURE AND MECHANIC ARTS. Bozeman, Mont.

1903. MOORE, HERBERT F. Assistant Professor of Theoretic and Applied Mechanics, University of Illinois, 710 Hill Street, Champaign, Ill.

1909. ‡MOORE, JOSEPH K. Ceramic Engineer and Chemist, Pacific Clay Products Bureau, 701 Lowman Building, Seattle, Wash.

1902. MOORE, WILLIAM HARLEY. Engineer of Bridges, New York, New Haven and Hartford Railroad, New Haven, Conn.

1909. *MORRIS, D. A. Metallurgical Engineer, Nelson Valve Company, Chestnut Hill, Philadelphia, Pa.

MORRIS, W. CULLEN (see *Society of Gas Engineering of New York*).

1911. ‡MORROW, JAMES G. Inspecting Engineer, The Steel Company of Canada, Hamilton, Ontario, Canada.

1910. *MORSE, F. B. District Manager, Gulick-Henderson Company, 30 Church Street, New York, N. Y.

1910. *MORSE, ROBERT G. Assistant Treasurer, Massachusetts Steel Casting Company, Everett, Mass.

1911. MORY, A. V. H. Director of Chemical Research, Sears, Roebuck and Company, Chicago, Ill.

1904. MOSELEY, ALEXANDER W. Professor of Applied Mechanics, Lewis Institute, Chicago, Ill.

1909. MOYER, ALBERT. Manager, Sales Department, Vulcanite Portland Cement Company, 175 Fifth Avenue, New York, N. Y.

1909. MUCKENFUSS, A. M. Professor, University of Mississippi, University, Miss.

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ELECTED.

1904. MUDGE, H. U. Second Vice-President, Chicago, Rock Island and Pacific Railway Company, La Salle Street Station, Chicago, Ill.

MUELLER, FRANK E. (see *Roberts and Schaeffer Company*).

1899. *MUESER, WILLIAM. Civil Engineer; Member, Concrete Steel Engineering Company, 13-21 Park Row Building, New York, N. Y.

1908. *MUHLFELD, JOHN E. General Superintendent of Motive Power, Baltimore and Ohio Railroad Company, Baltimore, Md.

1903. MUNROE, CHARLES EDWARD. Head Professor of Chemistry, George Washington University, Washington, D. C.

1904. MUNSELL, A. W. Inspector of Materials, Detroit River Tunnel Company, Detroit, Mich.

1908. MUNSELL, J. A. Assistant Cement Inspector, Erie Railroad, Ninth and Provost Streets, Jersey City, N. J.

1910. MURPHY, DANIEL H. President, American Conduit Manufacturing Company, 1402 Keystone Building, Pittsburg, Pa.

1908. MURRAY, FREDERIC L. 244 Brighton Street, Belmont, Mass.

1910. *MURTAUGH, M. M. Consulting Hydraulic and Construction Engineer, Alta Club, Salt Lake City, Utah.

1910. MYER, C. R. Engineer in Charge, Line Inspection Material, Western Electric Company, 463 West Street, New York, N. Y.

1910. ‡MYERS, J. E. Chemist, New York State Highway Commission, 81 Lancaster Street, Albany, N. Y.

1910. NAIRN LINOLEUM COMPANY, THE. Kenneth Gerard MacKenzie, Chemist, Newark, N. J.

1908. NATIONAL CASH REGISTER COMPANY, THE. Manufacturers of Cash Registers. E. A. Deeds, Second Vice-President, Dayton, O.

1905. NATIONAL FIREPROOFING COMPANY. E. V. Johnson, Vice-President and Western Manager, 806 Hartford Building, Chicago, Ill.

1900. *NATIONAL TUBE COMPANY. Frank N. Speller, Metallurgical Engineer, Frick Building, Pittsburg, Pa.

1911. *‡NEAD, J. H. Metallurgist, H. H. Franklin Manufacturing Company, 220 Delaware Street, Syracuse, N. Y.

1909. NEAL, C. S. Manager, White Lead Department, Acme White Lead and Color Works, Detroit, Mich.

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ELECTED.

NEALE, JAMES (see *Brown and Company, Incorporated*).

1902. *NEFF, F. H. Professor of Civil Engineering, Case School of Applied Science, Cleveland, O.

1904. *NELSON, E. D. Engineer of Tests, Pennsylvania Railroad Company, Altoona, Pa.

1910. NELSON, GEORGE. City Engineer, Hermosa Beach, Cal.

1910. NELSON, JOHN H. Assistant Professor, Head of Department of Applied Mechanics, Case School of Applied Science, Cleveland, O.

NEMZEK, LEO P. (see *Lucas and Company*).

1906. NETTLETON, W. A. General Superintendent, Motive Power, Chicago, Rock Island and Pacific Railway Company, La Salle Street Station, Chicago, Ill.

1911. NEU, ADOLPH. Chemist, Knickerbocker Portland Cement Company, Hudson, N. Y.

1898. *NEWBERRY, SPENCER B. Manager, Sandusky Portland Cement Company, Sandusky, O.

1909. ‡NEWHALL, CHARLES A. Chief Chemist, Superior Portland Cement Company, Baker, Wash.

1909. *NEW JERSEY ZINC COMPANY. F. E. Pierce, Engineer, 55 Wall Street, New York, N. Y.

1911. *NEWSOME, EDGAR T. Treasurer, Asbestos Protected Metal Company, Canton, Mass.

1908. *NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY, ENGINEERING DEPARTMENT. A. W. Carpenter, Engineer of Structures, Exterior Zone, Grand Central Terminal, New York, N. Y.

1904. NEW YORK FIRE INSURANCE EXCHANGE. Henry E. Hess, Manager, 32 Nassau Street, New York, N. Y.

1907. *NIMMO, J. V. Care of Canadian Northern Pacific Railway, Burns Building, 18 Hastings Street, W., Vancouver, British Columbia, Canada.

1908. NOBLE AND COMPANY, R. E. Cement Experts, 217 Humboldt Bank Building, San Francisco, Cal.

1911. ‡NODERER, R. H. Chief Chemist, Lorain Steel Company, Johnstown, Pa.

1902. *NORRIS, GEORGE L. Engineer of Tests, American Vanadium Company, Frick Building, Pittsburg, Pa.

1903. NORTON, C. L. Assistant Professor of Heat Measurement, Massachusetts Institute of Technology, Boston, Mass.

1910. NORTON, HOMER B. Chief Engineer, Electric Tanning Company, 302 Adams Avenue, Ridgway, Pa.

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ELECTED.

1909. *NOVELLA, CHARLES F. Engineer, Guatemala City, Guatemala.

1907. NUGENT, JOHN W. Librarian, Rensselaer Polytechnic Institute, 30 Second Street, Troy, N. Y.

1910. *OAKDEN, W. L. Director, Research Laboratory, American Optical Company, Southbridge, Mass.

1909. *OBER, JULIUS E. Metallurgist and Chemist, 222 North Craig Street, Pittsburg, Pa.

1911. *OBERKIRCH, FRANK. President and General Manager, St. Mary's Sewer Pipe Company, St. Marys, Pa.

1908. O'HARA, J. M. Official Cement Tester, Southern Pacific Company, 1109 Flood Building, San Francisco, Cal.

1911. *OLSEN, THORSTEN Y. General Manager, Tinius Olsen and Company, 500 North Twelfth Street, Philadelphia, Pa.

1898. *OLSEN, TINIUS. Tinius Olsen and Company, Testing Machines, 500 North Twelfth Street, Philadelphia, Pa.

1910. O'MALLEY, WILLIAM. Assistant Engineer, The Cuban Central Railways, Prodo 93a, Havana, Cuba.

1903. ORFORD COPPER COMPANY. H. E. Flewellin, 43 Exchange Place, New York, N. Y.

1911. ‡ORR, GEORGE. Assistant to City Engineer, 9 Cottage Street, Gloversville, N. Y.

1902. ORTON, EDWARD, JR. Dean, College of Engineering, Ohio State University; State Geologist of Ohio, Columbus, O.

1898. OSBORN ENGINEERING COMPANY, THE. Frank C. Osborn, Cleveland, O.

OSBORN, FRANK C. (see *Osborn Engineering Company*).

1911. *‡OSBORNE, CHARLES G. Superintendent, Special Steels, Illinois Steel Company, South Works, Chicago, Ill.

OSBORNE, L. A. (see *Westinghouse Electric and Manufacturing Company*).

1907. OSBORNE, RAYMOND GAYLORD. Inspector of Cement, 401 West Twenty-third Street, Los Angeles, Cal.

1903. *OSTROM, JOHN N. Bridge Engineer, 1518 Farmers' Bank Building, Pittsburg, Pa.

1904. *OTIS, SPENCER. Mechanical Engineer, 1707 Railway Exchange Building, Chicago, Ill.

1902. OUTERBRIDGE, ALEXANDER E., JR. Chemist and Metallurgist, 1600 Hamilton Street, Philadelphia, Pa.

1904. *OWEN, JAMES. Civil Engineer, 196 Market Street, Newark, N. J.

OWENS, R. B. (see *Franklin Institute*).

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ELECTED.

1910. *PAFF, CHARLES. Architect, Merchants' Exchange Building, San Francisco, Cal.

1903. PAGE, LOGAN WALLER. Director, Office of Public Roads, United States Department of Agriculture, Washington, D. C.

1909. PAGE, W. MARSHALL. Engineer, Duplex Metals Company, Chester, Pa.

1908. PAGE, WILLIAM NELSON. President, Gauley Mountain Coal Company, Ansted, W. Va.

1911. ‡PARDEE, HOMER A. Metallurgical Chemist, Crucible Steel Company of America, Syracuse, N. Y.

PARKER, J. H. (see *Carpenter Steel Company*).

1909. PARKS, A. M. President, A. M. Parks Company, 645 The Bourse, Philadelphia, Pa.

1908. *PARR, S. W. Professor of Applied Chemistry, University of Illinois, Urbana, Ill.

PATTERSON, W. J. (see *Heyl and Patterson, Incorporated*).

1906. PATTON, LUDINGTON. Secretary-Treasurer, Patton Paint Company, Milwaukee, Wis.

1908. PAUL, CHARLES E. Care of Armour Institute, Chicago, Ill.

1906. PAYNE, HENRY. Professor of Engineering, University of Melbourne, Australia.

1908. PAYNE, T. P. Payne Brothers, Incorporated, Emmett Street and D Avenue, Newark, N. J.

1911. *PEASE, BURTON H. Chief Inspector, Carnegie Steel Company, Sharon, Pa.

1896. PEASE, F. N. Chemist, Pennsylvania Railroad, Box 503, Altoona, Pa.

1908. PECK AND COMPANY, FRANCIS J. Mining Engineers and Chemists, 731–735 Williamson Building, Cleveland, O.

1903. PECKITT, LEONARD. President, Empire Steel and Iron Company, Catasauqua, Pa.

1911. *PENDER, BENJAMIN D. Inspector, Mechanical Division, Isthmian Canal Commission, Gorgona, Canal Zone.

1911. PENN STEEL CASTINGS AND MACHINE COMPANY. Walter S. Bickley, President and General Manager, Chester, Pa.

PENNEY, R. L. (see *Winchester Repeating Arms Company*).

1906. PENNIMAN AND BROWNE. Consulting Chemists, 213 Courtland Street, Baltimore, Md.

1909. *PENNSYLVANIA CRUSHER COMPANY. G. W. Borton, General Manager, Stephen Girard Building, Philadelphia, Pa.

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ELECTED.

1902. PENNSYLVANIA STEEL COMPANY, THE. J. V. W. Reynders, Vice-President Steelton, Pa.

1908. *PENNY, EDGAR. Vice-President and General Manager, Newburgh Ice Machine and Engine Company, Newburgh, N. Y.

1910. PERKINS, GEORGE H. Superintendent of Refineries, Warren Brothers Company, Boston, Mass. *For Mail:* 5 Irving Terrace, Cambridge, Mass.

1910. PERLEY, ALAN B. Consulting Engineer, 46 Gowen Avenue, Mt. Airy, Philadelphia, Pa.

1911. ‡PERLEY, GEORGE A. Chemist, Albany Lubricating Company, 708 Washington Street, New York, N. Y.

1904. *PERLEY, GEORGE E. Cement Expert, Department of Public Works, Ottawa, Canada.

1907. PERRY, R. S. President, Harrison Brother and Company, Incorporated, Philadelphia, Pa.

1905. *PEW, J. HOWARD. Assistant Manager of Refinery, Sun Company, Marcus Hook, Pa.

1911. ‡PHILLIPS, OLIVER. Inspector of Steel, Delaware, Lackawanna and Western Railroad, 312 Lake Street, Elmira, N. Y.

1910. PHILLIPS, W. R. Mechanical Engineer, 419 Lumber Exchange Building, Portland, Ore.

1909. PICKARD, GLENN H. Care of G. D. Wetherill and Company, 114 North Front Street, Philadelphia, Pa.

PIERCE, F. E. (see *New Jersey Zinc Company*).

1910. *PINKERTON, ANDREW. Electrical Engineer, American Sheet and Tin Plate Company, 1007 Frick Building, Pittsburg, Pa.

1908. PIPER, H. D. 5106 West Twenty-second Place, Morton Park, Chicago, Ill.

1904. *PITTSBURG FORGE AND IRON COMPANY. W. I. Miller, Secretary, Pittsburg, Pa.

1905. *PITTSBURG TESTING LABORATORY. John M. Bailey, Secretary, 325 Water Street, Pittsburg, Pa.

1910. PLOCK, A. F. Chief Engineer, The Northwestern Iron Company, Mayville, Wis.

1910. ‡PLUMB, R. ALFRED. Director, Michigan Technical Laboratory, 58 Lafayette Avenue, Detroit, Mich.

1902. *POLK, ANDERSON. Associated with The Lowe Brothers Company, Dayton, O. *For Mail:* The Engineers' Club, 32 West Fortieth Street, New York, N. Y.

POLK, MARY (see *Bureau of Science*).

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ELECTED.

1906. POLSON, JOSEPH A. East Lansing, Mich.

1904. *POMEROY, LEWIS R. Special Representative, Railway Department, General Electric Company, 44 Broad Street, New York, N. Y.

1908. POORMAN, ALFRED P. Assistant Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

1909. ‡POPE, GEORGE S. Assistant Engineer, Technologic Branch, Bureau of Mines, Washington, D. C.

1911. *PORTER, H. F. J. Industrial Engineer, 1 Madison Avenue, New York, N. Y.

1898. PORTER, JAMES MADISON. Professor of Civil Engineering, Lafayette College, Easton, Pa.

POTTER, ALFRED C. (see *Harvard College Library*).

1907. POTTS, STEPHEN C. Assistant Chemist, Pennsylvania Railroad. *For Mail:* 2413 Broad Avenue, Altoona, Pa.

1903. *POWERS, W. A. Chief Chemist, Atchison, Topeka and Santa Fé Railroad, Topeka, Kan.

1904. *PRENTISS, GEORGE N. Chemist, Chicago, Milwaukee and St. Paul Railway, 226 Thirty-third Street, Milwaukee, Wis.

1904. PRESTON, S. R. Port Colbone, Ontario, Canada.

1909. ‡PRETSCH, CHARLES J. Resident Inspector, Pittsburg Testing Laboratories, 317 Walnut Street, Harrisburg, Pa.

1909. *PRICE, CHARLES P. Manager, American Tar Company, Box 65, Malden, Mass.

1903. PRICE, MORTON MOORE. Sales Agent, Babcock and Wilcox Company, North American Building, Philadelphia, Pa.

PRINTZ, STEWART E. (see *Lehigh Valley Railroad Company*).

1905. *PROVOST, ANDREW J., JR. Sanitary Expert and Hydraulic Engineer, 39 West Thirty-eighth Street, New York, N. Y.

1908. *PRYOR, FREDERICK L. Professor of Experimental Engineering, Stevens Institute, Hoboken, N. J.

PULLAR, H. B. (see *American Asphaltum and Rubber Company*).

1904. PURDON, C. D. Chief Engineer, Cotton Belt Railroad, 6157 Kingsbury Boulevard, St. Louis, Mo.

1908. PURDUE UNIVERSITY LIBRARY. W. M. Hepburn, Librarian, Lafayette, Ind.

1903. QUIMBY, H. H. Assistant Engineer of Bridges, Bureau of Surveys, 3920 Girard Avenue, Philadelphia, Pa.

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ELECTED.

1909. RADER, B. H. Eastern Sales Agent, Universal Portland Cement Company, 524 Frick Building, Pittsburg, Pa.

1902. RAILWAY AND ENGINEERING REVIEW. W. M. Camp, Editor, 1305 Manhattan Building, Chicago, Ill.

1911. RAILWAY STEEL SPRING COMPANY. A. S. Henry, Vice-President, 30 Church Street, New York, N. Y.

RAKE, J. L. (see *Barber Asphalt Paving Company*).

1904. RAMAGE, J. C. Superintendent of Tests, Southern Railway Company, Alexandria, Va.

1904. RAMSAY, H. MARTYN. General Inspector, Pennsylvania Railroad Company, Altoona, Pa.

1908. RANDALL, D. T. Mechanical Engineer, 70 Smith Avenue, Detroit, Mich.

1896. *RANDOLPH, LINGAN S. Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

1907. *RAQUET, E. H. Chief Chemist, New York, New Haven and Hartford Railroad Company, West Haven, Conn.

1911. RAWSON, CHARLES A. President, Iowa Pipe and Tile Company, Des Moines, Iowa.

1909. RAYMOND CONCRETE PILE COMPANY. Maxwell M. Upson, Secretary and General Manager, 140 Cedar Street, New York, N. Y.

1909. RAYMOND, M. Assistant Engineer, Department of Docks, 507 West One Hundred and Thirteenth Street, New York, N. Y.

1902. READING IRON COMPANY. George Schuhman, Vice-President and General Manager, Reading, Pa.

1910. ‡RECTANUS, S. R. Superintendent, Galvanizing Department, American Rolling Mills Company, Middletown, O.

1910. *REED, M. E. Lieutenant-Commander, United States Navy, School of Marine Engineering, United States Naval Academy, Annapolis, Md.

1904. REEVE, C. S. Assistant Chemist, Office of Public Roads, United States Department of Agriculture, Washington, D. C.

1911. ‡REINKE, W. B. Assistant Engineer, Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1908. *REMINGTON ARMS AND AMMUNITION COMPANY. Nathan A. Chase, Chemist, Box 115, Ilion, N. Y.

1909. ‡RENINGER, HENRY A. Chemist, Lehigh Portland Cement Company, Allentown, Pa.

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ELECTED.

1911. REVUE DE METALLURGIE. H. Le Chatelier, Editor, 75 Notre Dame de Champes, Paris, France.

1906. REYNDERS, J. V. W. Vice-President, Pennsylvania Steel Company, Steelton, Pa.

REYNOLDS, M. P. (see *Tyler Company*).

RHODES, CHARLES F. (see *International Paper Company*).

1910. RHODES, T. ECKFORD. Chief Engineer, Whitney-Steen Company, 1 Liberty Street, New York, N. Y.

1898. RICE, FRANCIS S. Engineer of Bridges, St. Louis and San Francisco Railroad Company, 943 Frisco Building, St. Louis, Mo.

1909. RICE, H. A. Associate Professor of Civil Engineering, University of Kansas, 1233 Massachusetts Street, Lawrence, Kan.

RICE, HERBERT W. (see *United States Gutta Percha Paint Company*).

1900. RICHARDS, JOSEPH T. Chief Engineer, Maintenance of Way, Pennsylvania Railroad, Broad Street Station, Philadelphia, Pa.

1902. *RICHARDS, JOSEPH W. Professor of Metallurgy, Lehigh University, South Bethlehem, Pa.

1902. *RICHARDS, ROBERT H. Professor of Mining Engineering and Metallurgy, Massachusetts Institute of Technology, Boston, Mass.

1896. *RICHARDSON, CLIFFORD. Consulting Engineer, 30 Church Street, New York, N. Y.

1911. ‡RIDDELL, W. C. Chemical Engineer, Pacific Portland Cement Company, 823 Pacific Building, San Francisco, Cal.

1910. *‡RIEGER, WILLIAM H. Chemist, Heppenstall Forge and Knife Company, Pittsburg, Pa.

1902. RIEGNER, W. B. Engineer of Bridges, Philadelphia and Reading Railway, Reading Terminal, Philadelphia, Pa.

1898. *RIEHLÉ, FREDERICK A. Riehlé Brothers Testing Machine Company, 1424 North Ninth Street, Philadelphia, Pa.

1910. RIGG, GILBERT. Chemist, Head of Research Department, New Jersey Zinc Company, Palmerton, Pa.

1908. RIGHTS, LEWIS D. Civil Engineer, care of L. F. Shoemaker and Company, 45 Broadway, New York, N. Y.

1907. *RINALD, C. D. Rinald Brothers, Paint Manufacturers, 1142 North Hancock Street, Philadelphia, Pa.

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ELECTED.

1907. ‡RISTINE, JOHN D. Railway Representative, The Lowe Brothers Company, 470 The Rookery, Chicago, Ill.

1909. RITTER, DANIEL E. Assistant to President, Lehigh Portland Cement Company, Allentown, Pa.

1904. *ROBERTS, ALFRED E. Analytical and Consulting Chemist and Metallurgist, Bull and Roberts, 100 Maiden Lane, New York, N. Y.

1908. ROBERTS AND SCHAEFER COMPANY. Consulting Engineers and Contractors. Frank E. Mueller, Secretary, 1270 Old Colony Building, Chicago, Ill.

1904. ROBERTSON, LESLIE S. Secretary of the Engineering Standards Committee, 28 Victoria Street, London, England.

1904. *ROBINSON, A. F. Bridge Engineer, Atchison, Topeka and Santa Fé Railway System, 1000 Railway Exchange Building, Chicago, Ill.

1908. ROBINSON, A. L. Electrical Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1908. ROBINSON, C. SNELLING. Second Vice-President, Youngstown Sheet and Tube Company, Youngstown, O.

1908. ROBINSON, F. W. Superintendent of Plants, Pratt and Lambert, 79 Tonawanda Street, Buffalo, N. Y.

1910. ROBINSON, G. P. Inspector of Locomotive Boilers, Public Service Commission, 8 Chestnut Street, Albany, N. Y.

1911. ‡ROBINSON, LOUIS G. Engineer and Chemist, Harrison Building, Cincinnati, O.

1904. *ROCK PRODUCTS. Fred K. Irvine, Technical Editor, 537 South Dearborn Street, Chicago, Ill.

1906. RODGERS, S. M. Metallurgist, American Steel and Wire Company, 819 Frick Building, Pittsburg, Pa.

1909. *RODMAN, H. B. Chemist, Chemical Laboratory, Pennsylvania Railroad Company, Altoona, Pa.

1900. *ROEBLING'S SONS COMPANY, JOHN A. H. J. Horne, Assistant Superintendent, Department of Wire-drawing, Trenton, N. J.

1910. ROGERS, ALLEN. In charge of Industrial Chemistry, Pratt Institute, Brooklyn, N. Y.

1910. ‡ROGERS, JOHN I. Consulting Engineer, 165 Broadway, New York, N. Y.

1911. *ROSE, FLOYD. Inspecting Engineer, 901 Fulton Building, Pittsburg, Pa.

1905. *ROSENHEIM, A. F. Architect, H. W. Hellman Building, Los Angeles, Cal.

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ELECTED.

1911. *ROSS, H. A. Treasurer, The Vancouver Portland Cement Company, Limited, Box 681, Victoria, British Columbia, Canada.

1905. *ROSSI, JAMES C. General Superintendent, National Fireproofing Company, 71 Lewis St., Perth Amboy, N. J.

1909. ‡ROTE, JOHN G. Manager, Gillette Safety-Razor Company, First and Colton Streets, Boston, Mass.

1911. ROTHSTEIN, E. KELLY. Vice-President and General Manager of Sales, Davis Coal and Coke Company, 700 Continental Building, Baltimore, Md.

1910. *‡ROWLAND, WILLIAM S. Chemical Engineer, The Stanley Works, New Britain, Conn.

1903. ROYAL, JOSEPH. Inspecting Engineer, 1015 Harrison Building, Philadelphia, Pa.

1911. ‡ROYS, FRANCIS WILLIAM. Instructor in Mechanical Engineering, Worcester Polytechnic Institute, 132 Elm Street, Worcester, Mass.

1906. RUGGLES, WILLIAM B. Mechanical Engineer, 39 Cortlandt Street, New York, N. Y.

RUNKLE, E. W. (see *Carnegie Library, Pennsylvania State College*).

1908. ‡RUPP, MANNING E. 303 East Fourth Street, New York, N. Y.

1911. *RUPPEL, HENRY E. K. Chemist, Gillette Safety Razor Company, 21 Wollaston Avenue, Wollaston, Mass.

1910. ‡RUSSELL, A. A. M. Assistant Chemist, Board of Public Works, 349 Frederick Street, San Francisco, Cal.

1906. *RUSSELL, ERNEST JOHN. Architect, Chemical Building, St. Louis, Mo.

1909. RUST, ROBERT R. Superintendent of Foundries, Central Foundry Company, 37 Wall Street, New York, N. Y.

1904. RUTHENBURG, MARCUS. Metallurgical Engineer, Electrical Federation Offices, Kingsway, London, W. C., England.

1908. RYERSON AND SON, JOSEPH T. Iron and Steel. Edward T. Hendee, Sixteenth and Rockwell Streets, Chicago, Ill.

1908. *RYS, C. F. W. Metallurgist, Carnegie Steel Company, 521 Carnegie Building, Pittsburg, Pa.

1898. SABIN, A. H. Chemist, 432 Sanford Avenue, Flushing, N. Y.

1902. SABIN, L. C. General Superintendent, St. Mary's Falls Canal, Sault Ste. Marie, Mich.

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1911. SADTLER AND SON, SAMUEL P. Consulting and Analytic Chemists, 39 South Tenth Street, Philadelphia, Pa.

1909. *‡SAKLATWALLA, B. Metallurgist, American Vanadium Company, 227 Halket Street, Pittsburg, Pa.

1904. *SALMON, FREDERICK W. Civil and Mechanical Engineer, 109 South Woodlawn Avenue, Burlington, Iowa.

1910. *‡SANBORN, JOHN R. Manager of Works, Art Metal Construction Company, Jamestown, N. Y.

1910. ‡SANGER, F. M., JR. Assistant Superintendent, Tyler Tube and Pipe Company, Washington, Pa.

1908. SARGENT, FITZ WILLIAM. Chief Engineer, American Brake-Shoe and Foundry Company, Box 15, Mahwah, N. J.

1910. *SARGENT, GEORGE W. Fourth Vice-President, Crucible Steel Company of America, Empire Building, Pittsburg, Pa.

1902. *SAUNDERS, WALTER M. Analytical and Consulting Chemist, 184 Whittier Avenue, Providence, R. I.

1896. *SAUVEUR, ALBERT. Metallurgical Engineer; Professor of Metallurgy, Harvard University, Rotch Building, Cambridge, Mass.

1908. SAWYER, ARTHUR HENRY. Cement Inspector, The Hudson Manhattan Railroad Company, 98 Hudson Street, Jersey City, N. J.

1903. SCARBOROUGH, F. W. Mining Engineer, 816 Mutual Building, Richmond, Va.

1904. SCHADE, G. C. 314 West College Street, Canonsburg, Pa.

1908. SCHALL, FREDERICK E. Bridge Engineer, Lehigh Valley Railroad, South Bethlehem, Pa.

1907. *SCHEIDEL, A. Managing Director, The Commonwealth Portland Cement Company, Mutual Life of New York Building, Martin Place, Sydney, Australia.

1909. SCHENECTADY VARNISH COMPANY. W. H. Wright, Schenectady, N. Y.

1908. *SCHILDHAUER, EDWARD. Electrical and Mechanical Engineer, Isthmian Canal Commission, Department of Construction and Engineering, Culebra, Canal Zone.

1908. SCHLUEDERBERG, GEORGE W. Coal Operator, 210 West Craig Street, Pittsburg, Pa.

1909. SCHMIDT, CHARLES. Chief Engineer, Peerless Motor Car Company, Cleveland, O.

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ELECTED.

1904. *SCHMITT, F. E. Associate Editor, *Engineering News*, 220 Broadway, New York, N. Y.

1905. SCHNEIDER, C. C. Consulting Engineer, Pennsylvania Building, Philadelphia, Pa.

1900. SCHNEIDER, HERMAN. Professor of Civil Engineering, University of Cincinnati, Cincinnati, O.

1906. SCHNELL, HARRY J. Editor and Manager, *Oil, Paint and Drug Reporter*, *The Druggists' Circular* and *The Painters' Magazine*, 100 William Street, New York, N. Y.

1905. *SCHNIEWIND, F. Consulting Chemical Engineer; Vice-President, The United Coke and Gas Company, 17 Battery Place, New York, N. Y.

1908. SCHOLZ, CARL. Manager, Mining Department, Chicago, Rock Island and Pacific Railway Company, Old Colony Building, Chicago, Ill.

1910. SCHREIBER, MARTIN. Engineer, Maintenance of Way, Public Service Railway Company, Newark, N. J.

1909. SCHRODTER, E. Secretary, Verein Deutscher Eisenhüttenleute, Düsseldorf 74, 27 Breite Strasse, Germany.

1911. *SCHOOL OF MARINE ENGINEERING LIBRARY. M. E. Reed, Lieutenant-Commander, United States Navy, Head of School, United States Naval Academy, Annapolis, Md.

1902. SCHUERMAN, W. H. Dean of Engineering Department and Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn.

SCHUHMAN, GEORGE (see *Reading Iron Company*).

SCHUYLER, MONT (see *Testing Laboratory, City of St. Louis*).

1910. SCHWARCMAN, ALEXANDER. Chemist, Spencer Kellogg and Sons, Buffalo, N. Y.

1905. SCHWARTZ, ARCHIE W. Inspector, Bureau of Buildings, Borough of Manhattan, 80 East Washington Square, New York, N. Y.

1907. SCHWARTZ, HARRY A. Chemist, The National Malleable Castings Company. *For Mail:* 522 Tibbs Avenue, Indianapolis, Ind.

1911. *SCHWENDENER, KARL D. Assistant Inspector of Buildings, City of Los Angeles, 2078 West Twenty-seventh Street, Los Angeles, Cal.

1908. *SCOFIELD, H. H. Instructor in Testing Materials, Purdue University, 234 S. Pierce Street, West Lafayette, Ind.

1910. *SCOTT, ARTHUR P. Metallurgist, Allegheny Steel Company, Brackenridge, Pa.

SCOTT, D. G. (see *American Iron and Steel Manufacturing Company*).

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1911. SCOTT, ROBERT G., JR. Chief Order Clerk, American Sheet and Tin Plate Company, Vandergrift, Pa.

1904. *SCOTT, WILLIAM F. Structural Engineer, Dunnville, Canada.

1905. SCRIBNER, C. E. Chief Engineer, Western Electric Company, 463 West Street, New York, N. Y.

1910. *‡SEABURY, RICHARD W. Secretary and Treasurer, Boonton Rubber Company, Box 423, Boonton, N. J.

1898. SEAMAN, HARRY J. Superintendent, Atlas Cement Company, Catasauqua, Pa.

1902. SEAMAN, HENRY B. Consulting Engineer, 165 Broadway, New York, N. Y.

1906. SEARS, W. T. Engineering Bureau, Niles-Bement-Pond Company, Twenty-first and Callowhill Streets, Philadelphia, Pa.

1908. *SEAVER, J. W., JR. Civil Engineer, Waynesville, N. C.

SELLERS, COLEMAN, JR. (see *Sellers and Company, Incorporated*).

1910. SELLERS, JAMES C., JR. Standard Steel Works Company, Morris Building, Philadelphia, Pa.

1904. *SELLERS AND COMPANY, INCORPORATED, WILLIAM. Coleman Sellers, Jr., President, 1600 Hamilton Street, Philadelphia, Pa.

1910. SELLEW, WILLIAM H. Principal Assistant Engineer, Michigan Central Railroad, 82 Rowena Street, Detroit, Mich.

1906. *SEMET-SOLVAY COMPANY. O. S. Doolittle, Sales Agent, 17 Battery Place, New York, N. Y.

1910. *SEXTON, F. H. President, Nova Scotia Technical College, Halifax, Nova Scotia, Canada.

1911. ‡SHAFFER, CARLETON B. Inspector, Department of Public Works, United States Navy Yard, Norfolk, Va.

1911. SHAFFER, GUY F. Draftsman with Cass Gilberts, Architect, 11 East Twenty-fourth Street, New York, N. Y.

1902. *SHANKLAND, E. C. AND R. M. Civil Engineers, 1106 Rookery, Chicago, Ill.

1907. SHANNON, CHARLES. 617 Liberty Avenue, Pittsburg, Pa.

SHARP, CLAYTON H. (see *Electrical Testing Laboratories*).

1909. SHARPLES, PHILIP P. Chemist, 297 Franklin Street, Boston, Mass.

1911. SHEAFE, JAMES S. Engineer of Tests, Illinois Central Railroad, Burnside Shops, Chicago, Ill.

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ELECTED.

1911. SHEFFIELD SCIENTIFIC SCHOOL LIBRARY. L. P. Breckenridge, Professor of Mechanical Engineering, 111 Winchester Hall, New Haven, Conn.

1910. SHEPARD, WILLIAM KENT. Instructor in Mechanics, Yale University, 155 Linden Street, New Haven, Conn.

1904. ‡SHERMAN, HERBERT L. Industrial and Engineering Chemist, 12 Pearl Street, Boston, Mass.

1906. SHERRERD, JOHN M. General Sales Agent, Taylor Iron and Steel Company, High Bridge, N. J.

1903. SHERRERD, MORRIS R. Engineer and Superintendent, Department of Water, City of Newark, 128 Halsey Street, Newark, N. J.

1902. SHERWIN-WILLIAMS COMPANY, THE. Paint and Varnish Makers. E. C. Holton, Chemist-in-Chief, 100 Canal Street, Cleveland, O.

1899. *SHIMER, PORTER W. Chemist and Metallurgist, Easton, Pa.

SHOEMAKER, C. B. (see *Glasgow Iron Company*).

1910. SHOEMAKER, M. N. Vice-President and Treasurer, American Concrete-Steel Company, 718 Union Building, Newark, N. J.

1910. SHORE, ALBERT F. President, Shore Instrument Company, 557 West Twenty-second Street, New York, N. Y.

1906. SHULTS, CHARLES. Salesman, Worth Brothers Company, 111 Broadway, New York, N. Y.

1902. SHUMAN, JESSE J. Inspecting Engineer, Testing Department, Jones and Laughlin Steel Company, Pittsburg, Pa.

1910. *‡SIMON, S. K. Chief Chemist, Southwestern Portland Cement Company, El Paso, Texas.

1908. SIPE, JAMES B. President, James B. Sipe and Company, North Side, Pittsburg, Pa.

1903. *SKINNER, C. E. Electrical Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.

1908. SKINNER, HERVEY J. Vice-President, Arthur D. Little, Incorporated, 93 Broad Street, Boston, Mass.

1904. *SKINNER, ORVILLE CAMPBELL. Assistant Superintendent, Standard Steel Works Company, Burnham, Pa.

1910. SLOCUM, CHARLES V. Special Agent, The Titanium Alloy Manufacturing Company, 5500 Irwin Avenue, Pittsburg, Pa.

1908. *SLOCUM, FRANK S. Special Representative, Jones and Laughlin Steel Company, Pittsburg, Pa.

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ELECTED.

SMITH, C. C. (see *Union Steel Casting Company*).

1907. SMITH, CHARLES E. Maintenance of Way Department, Missouri Pacific Railway Company, St. Louis, Mo.

1908. SMITH, C. M. Assistant Professor of Physics, Purdue University, 910 South Ninth Street, Lafayette, Ind.

1906. *SMITH, EMERY AND COMPANY. Chemists and Chemical Engineers, 651 Howard Street, San Francisco, Cal.

1906. *SMITH, E. B. In charge of Mechanical Laboratories, Drexel Institute, Thirty-second and Chestnut Streets, Philadelphia, Pa.

1907. SMITH, FRANCIS P. Chemical Engineer, 24–26 East Twenty-first Street, New York, N. Y.

1902. *SMITH, H. E. Chemist, The Lake Shore and Michigan Southern Railway Company, 36 Beersford Place, East Cleveland, O.

1910. SMITH, H. LE H. Chief of Testing Bureau, Brooklyn Rapid Transit Company, Kent and Division Streets, Brooklyn, N. Y.

1911. SMITH, J. HAMMOND. Professor of Civil Engineering, University of Pittsburg, Pittsburg, Pa.

1908. SMITH, KERRY AND CHACE. Consulting and Constructing Engineers, 124-126 Confederation Life Building, Toronto, Canada.

1910. SMITH, LAWRENCE SOUTHWICK. Instructor in Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1909. ‡SMITH, STUART. Chief Chemist, The Superior Portland Cement Company, Superior, Ohio.

SMITH, W. ACHESON (see *International Acheson Graphite Company*).

SMOOT, A. M. (see *Ledoux and Company*).

1902. *SNOW, J. P. 1120 Kimball Building, Boston, Mass.

1908. SOCIETY OF GAS ENGINEERING OF NEW YORK. W. Cullen Morris, 4 Irving Place, New York, N. Y.

1909. *SOMMER, ALBERT. Consulting Chemist, 17 Battery Place, New York, N. Y.

1904. SOMMERVILLE, C. W. Architect, Union Trust Building, Washington, D. C.

1903. *SOUTHER, HENRY. Consulting Metallurgical Engineer; State Chemist, 440 Capitol Avenue, Hartford, Conn.

1904. *SPACKMAN ENGINEERING COMPANY, HENRY S. 42 North Sixteenth Street, Philadelphia, Pa.

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ELECTED.

1905. SPALDING, F. P. Professor of Civil Engineering, University of Missouri, Columbia, Mo.

1902. SPANGLER, H. W. Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa.

1905. *SPARE, C. R. Vice-President, American Manganese Bronze Company, Holmesburg, Philadelphia, Pa.

1906. SPARHAWK, GEORGE F. Engineer, American Bridge Company, Ambridge, Pa.

1910. *SPAULDING, RALPH E. With Aberthaw Construction Company, Boston, Mass. *For Mail:* Suffield, Conn.

SPELLER, FRANK N. (see *National Tube Company*).

1909. *SPENCER, HERBERT. Civil Engineer, 26 Broadway, New York, N. Y.

1911. ‡SPENGLER, J. H. Assistant in Mechanics, Rensselaer Polytechnic Institute, 2347 Fifteenth Street, Troy, N. Y.

1909. *SPERRY, EDWIN S. Metallurgist, *The Brass World*, 260 John Street, Bridgeport, Conn.

1901. SPERRY, W. L. President and Manager, The Cumberland Hydraulic Cement and Manufacturing Company, Box 264, Cumberland, Md.

1906. SPRAGUE, L. G. Chemist, Virginia Portland Cement Company, Fordwick, Va.

1908. SQUIRES, WILLIS C. Consulting Engineer, 209 Western Union Building, Chicago, Ill.

1911. *STACKS, D. H. Technical Investigator, Deere and Company, Moline, Ill.

1908. STAFFORD, C. EDWARD. Union League, Philadelphia, Pa.

1909. *STAFFORD, SAMUEL G. Vice-President and General Manager, Vulcan Crucible Steel Company, Alequippa, Pa.

1908. STANDARD ASPHALT AND RUBBER COMPANY. W. L. Levering, Treasurer, 205 La Salle Street, Chicago, Ill.

1908. STANDARD SCREW COMPANY. E. H. Ehrman, Secretary and Factory Manager, Chicago Screw Company, 1026 South Homan Avenue, Chicago, Ill.

1902. *STANDARD STEEL WORKS COMPANY. William Vollmer, Superintendent, Burnham, Pa.

1909. STANDARD UNDERGROUND CABLE COMPANY. C. C. Baldwin, Superintendent, Wire and Rod Mill, Perth Amboy, N. J.

1910. STANFORD UNIVERSITY, LELAND, JUNIOR. G. T. Clark, Librarian, Stanford University, Cal.

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ELECTED.

1905. STANGER, R. H. HARRY. Consulting Engineer, Testing Works and Chemical Laboratories, 2 Broadway, Westminster, London, S. W., England.

1907. *STANSFIELD, ALFRED. Professor of Metallurgy, McGill University, Montreal, Canada.

1903. STAPLETON, F. M. Mechanical Inspector, Union Pacific Railroad Company, 30 Plymouth Avenue, Buffalo, N. Y.

1910. STARR, JOHN J. Secretary, The Robinson Clay Products Company, Akron, O.

1907. STATE GEOLOGICAL SURVEY. H. F. Bain, Director, Urbana, Ill.

1896. *STEVENSON, A. A. Vice-President, Standard Steel Works Company, Morris Building, Philadelphia, Pa.

STEVENSON, JAMES S. (see *Berry Brothers, Limited*).

1908. STEVENSON, JOHN G. Inspector of Bridges, 249 Rochelle Avenue, Wissahickon, Philadelphia, Pa.

1911. STEWART, JOHN T. Professor of Agricultural Engineering, University of Minnesota, University Farms, St. Paul, Minn.

1909. STEWART, L. C. Generai Manager, Virginia Metal Culvert Company, Roanoke, Va.

1906. STILLMAN, HOWARD. Mechanical Engineer and Engineer of Tests, Southern Pacific Company, 2430 Piedmont Avenue, Berkeley, Cal.

1899. *STILLMAN, THOMAS B. Professor of Chemistry, Stevens Institute of Technology, Hoboken, N. J.

1909. STITT, HERBERT LEE. Inspector of Bridge Materials, Baltimore and Ohio Railroad, 1122 Locust Street, North Side, Pittsburg, Pa.

1909. STODDARD, RAYMOND FRENCH. Consulting Engineer, 83 Fairfield Avenue, Bridgeport, Conn.

1910. STONE, GEORGE C. Metallurgist, New Jersey Zinc Company, 55 Wall Street, New York, N. Y.

1910. ‡STONE, LAUSON. Assistant Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburg, Pa.

STONECIPHER, J. F. (see *Lafayette College Library*).

1903. STOREY, W. B., JR. Vice-President, Atchison, Topeka and Sante Fé Railroad Company, 1033 Railway Exchange Building, Chicago, Ill.

1906. STORRS, L. S. Vice-President, New England Investment and Security Company, Springfield, Mass.

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ELECTED.

1902. *STOUGHTON, BRADLEY. Metallurgist, 165 Broadway, New York, N. Y.

1910. STRACHAN, ROBERT C. Assistant Engineer, Department of Bridges, City of New York. *For Mail:* 371 Grant Avenue, Richmond Hill, N. Y.

1911. *STRANGE, WILLIAM WALLACE. Chemist, Box 151, Pony, Mont.

1907. STRATTON, S. W. Director, United States Bureau of Standards, Washington, D. C.

1909. *STRICKLER, G. B. President, Southern Sand and Gravel Company, Fredericksburg, Va.

1896. STROBEL, CHARLES L. Consulting Engineer, 1744 Monadnock Block, Chicago, Ill.

1908. STRONG, ROBERT M. Care of Mallinckrodt Chemical Works, St. Louis, Mo.

1910. *STUDEBAKER LIBRARY. Studebaker Brothers Manufacturing Company, South Bend, Ind.

1904. *STUETZ, E. 75 Victoria Street, London, S. W., England.

1909. SUMNER, WARREN E. Chemist, Box 13, East Walpole, Mass.

1906. SUYDAM, RICHARD S. President, M. B. Suydam Paint Company, Pittsburg, Pa.

1896. *SWAIN, GEORGE F. Professor of Civil Engineering, Graduate School of Applied Science, Harvard University, Pierce Hall, Oxford Street, Cambridge, Mass.

1903. SWANBERG, F. L. Secretary, The D. T. Williams Valve Company, 904–910 Broadway, Cincinnati, O.

1910. SWEETSER, E. O. Assistant Professor of Civil Engineering, Washington University, St. Louis, Mo.

1903. *SWENSSON, EMIL. Consulting Engineer, Frick Building, Pittsburg, Pa.

1908. SWITZER, JOHN A. Assistant Professor of Experimental Engineering, University of Tennessee, Knoxville, Tenn.

1905. *TABER, GEORGE H. General Manager, Gulf Refining Company, Frick Building, Pittsburg, Pa.

1903. TAGGART, HOWARD. Engineer of Tests, Lukens Iron and Steel Company, Box 632, Coatesville, Pa.

1898. *TALBOT, ARTHUR N. Professor of Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.

1902. TALBOT, HENRY P. Professor of Inorganic and Analytical Chemistry, Massachusetts Institute of Technology, Boston, Mass.

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ELECTED.

1904. TASSIN, WIRT. With Duplex Metals Company, Chester, Pa.

1904. TAUBENHEIM, ULRICH E. Manager, City Water Works, Archangel, Russia.

1909. *‡TAYLOR, C. MARSHALL. Superintendent, Tie Treating Plant, Philadelphia and Reading Railway, Philadelphia, Pa.

1909. TAYLOR, EDWARD H. President, Commercial Testing and Engineering Company, 1785 Old Colony Building, Chicago, Ill.

1908. TAYLOR, JOHN. Care of Iowa Portland Cement Company, Des Moines, Iowa.

1908. TAYLOR, JOHN O. 311 Daniel Street, Champaign, Ill.

1906. *TAYLOR, KNOX. President, Taylor Iron and Steel Company, High Bridge, N. J.

1900. TAYLOR, WILLIAM PURVES. Engineer in Charge, Testing Laboratory, 318 City Hall, Philadelphia, Pa.

1896. *TECHNISCHER VEREIN, NEW YORK. Carl Kaelble, Secretary, Room 719, Engineering Building, 29 West Thirty-ninth Street, New York, N. Y.

1911. *TEFFT, G. H. Secretary and Sales Manager, W. S. Dickey Clay Manufacturing Company, 200 New York Life Building, Kansas City, Mo.

1910. *TESTING LABORATORY, CITY OF ST. LOUIS. Mont Schuyler, Engineer-in-Charge, Kingshighway and Eager Road, St. Louis, Mo.

1910. TEXTOR, OSCAR. Analytical and Consulting Chemist, 603 Superior Avenue, N. W., Cleveland, O.

1902. THACHER, EDWIN. Consulting Engineer; Member, Concrete-Steel Engineering Company, Park Row Building, New York, N. Y.

THACKRAY, GEORGE E. (see *Cambria Steel Company*).

1907. ‡THELEN, ROLF. Mechanical Engineer, Forest Service, 316 Breese Terrace, Madison, Wis.

1900. *THOMAS, DAVID. Logan Iron and Steel Company, Burnham, Pa.

1908. THOMAS, GEORGE, 3D. Treasurer, Parkesburg Iron Company, Parkesburg, Pa.

1911. THOMAS, H. C. Assistant General Superintendent, Gary Works, Indiana Steel Company, 712 Jackson Street, Gary, Ind.

1906. ‡THOMPSON, G. SAXTON. Assistant in Mechanics, Rensselaer Polytechnic Institute, 689 Second Avenue, Troy, N. Y.

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ELECTED.

1903. *THOMPSON, GUSTAVE W. Chemist, National Lead Company, 129 York Street, Brooklyn, N. Y.

1905. *THOMPSON, HUGH L. Consulting Engineer, Waterbury, Conn.

1907. *THOMPSON, JOHN FAIRFIELD. Chief of Testing Department, The Orford Copper Company, New Brighton, Staten Island, N. Y.

1904. *THOMPSON, SANFORD E. Civil Engineer, Newton Highlands, Mass.

1908. THOMSON, REGINALD H. City Engineer, 701 Yetler Way, Seattle, Wash.

1911. THORPE, J. B. Chief Chemist, Gary Works, Indiana Steel Company, Box 614, Gary, Ind.

1908. ‡TIBBETTS, FRED W. Civil Engineer, Alaska Commercial Building, San Francisco, Cal.

1910. *TIEMANN, HUGH P. Metallurgist, Carnegie Steel Company, Pittsburg, Pa.

1908. TILT, EDWIN B. Engineer of Tests, Canadian Pacific Railway, 4278 Western Avenue, Westmount, Canada.

1909. TINKER, GEORGE H. Bridge Engineer, New York, Cincinnati and St. Louis Railway, 420 Hickok Building, Cleveland, O.

1908. ‡TISSING, DAVID. Assistant Chemist, Northern Pacific Railway Company, General Office Building, St. Paul, Minn.

1910. TITANIUM-ALLOY MANUFACTURING COMPANY, THE. Harry H. Cook, Metallurgist, 95 North Ashland Avenue, Buffalo, N. Y.

1903. *TOCH, MAXIMILIAN. Paint Manufacturer, 320 Fifth Avenue, New York, N. Y.

1903. TOMKINS, CALVIN. Commissioner of Docks and Ferries, Pier A, North River, New York, N. Y.

1903. TOUCEDA, ENRIQUE. Chemist and Metallurgist, 51 State Street, Albany, N. Y.

1906. TRAUTWEIN, A. P. President, Carbondale Instrument Company, Carbondale, Pa.

1907. *TRAUTWINE, JOHN C., JR. Civil Engineer, 257 South Fourth Street, Philadelphia, Pa.

TREAT, R. B. (see *Crocker-Wheeler Company*).

1906. TRETCH, WILLIAM J. Superintendent, Riehlé Brothers Testing Machine Company, 1424 North Ninth Street, Philadelphia, Pa.

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ELECTED.

1905. *TRIST, N. B. With Carnegie Steel Company, Fifth Avenue, Pittsburg, Pa.

1904. TROOIEN, O. N. Mechanical Engineer, 3007 Portland Avenue, Minneapolis, Minn.

1910. TROW, CHARLES A. Chief Engineer, California Midland Railroad, Marysvi'le, Cal.

1908. *TUCKER, HERMAN FRANKLIN. 60 Greenough Street, Brookline, Mass.

1904. TUFTS COLLEGE, DEPARTMENT OF ENGINEERING. Gardner C. Anthony, Dean, Tufts College, Mass.

1909. *TULANE UNIVERSITY, DEPARTMENT OF EXPERIMENTAL ENGINEERING. Professor W. B. Gregory, New Orleans, La.

1902. *TURNEAURE, F. E. Dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.

1906. *TURNER, HENRY C. President, Turner Construction Company, 11 Broadway, New York, N. Y.

1910. TYLER COMPANY, W. S. M. P. Reynolds, Sales Manager, Cleveland, O.

1908. UMSTADTER, J. M. Manager, Norfolk Office, M. J. Drummond and Company, Norfolk, Va.

1909. *UNGER, J. S. Manager, Central Research Laboratory, Carnegie Steel Company, Duquesne, Pa.

1908. *UNION DRAWN STEEL COMPANY. F. N. Beegle, President, Beaver Falls, Pa.

1907. UNION STEEL CASTING COMPANY. C. C. Smith, President, Sixty-first and Butler Streets, Pittsburg, Pa.

1908. UNITED GAS IMPROVEMENT COMPANY. W. H. Gartley, Engineer of Works (Philadelphia Gas Works), Twenty-third and Filbert Streets, Philadelphia, Pa.

1909. UNITED PAVING COMPANY. W. I. Cherry, President and General Manager, 537 Bartlett Building, Atlantic City, N. J.

1908. UNITED STATES CAST IRON PIPE AND FOUNDRY COMPANY. William B. Franklin, Manager, Philadelphia Branch, Morris Building, Philadelphia, Pa.

1907. *UNITED STATES GUTTA PERCHA PAINT COMPANY. Herbert W. Rice, Secretary, Providence, R. I.

1911. UNITED STATES SHERARDIZING COMPANY. Thomas Liggett, Jr., Assistant to President, New Castle, Pa.

1906. UNIVERSITY OF KANSAS, SCHOOL OF ENGINEERING. F. O. Marvin, Dean, Lawrence, Kan.

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ELECTED.

1911. UNIVERSITY OF NEVADA LIBRARY. J. D. Layman, Librarian, Reno, Nev.

1910. UNIVERSITY OF NORTH DAKOTA. Charles H. Compton, Librarian, University, N. D.

1910. UNIVERSITY OF PITTSBURG. Miss Katherine Elston, Librarian, Grant Boulevard, Pittsburg, Pa.

UPSON, MAXWELL M. (see *Raymond Concrete Pile Company*).

1910. *VALLAT, BENJAMIN W. Superintendent, Newport Mining Company, Ironwood, Mich.

1904. VAN CLEVE, A. H. Resident Engineer, The Niagara Falls Power Company, Niagara Falls, N. Y.

1906. VANDEVORT, F. F. Iron and Steel Agent, 66 Broadway, New York, N. Y.

1903. VAN GUNDY, C. P. Chief Chemist, Baltimore and Ohio Railroad, Mont Clare, Baltimore, Md.

1902. *VAN ORNUM, J. L. Professor of Civil Engineering, Washington University, St. Louis, Mo.

1909. ‡VAN TRUMP, ISAAC. Chief Chemist, The American Asphalt Paving Company, 2337 South Paulina Street, Chicago, Ill.

1908. ‡VAUCLAIN, JACQUES L. Engineer of Tests, Baldwin Locomotive Works, 500 North Broad Street, Philadelphia, Pa.

1908. VEITCH, F. Chief Chemist, Leather and Paper Laboratory, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

1910. VERITY, R. H. General Superintendent, Massey-Harris Company, Limited, Toronto, Canada.

1909. VIAL, F. K. Construction Engineer, Griffin Wheel Company, Sacramento Square, Chicago, Ill.

1909. *VIELE, BLACKWELL AND BUCK. Consulting Engineers, 49 Wall Street, New York, N. Y.

1896. VOGT, A. S. Mechanical Engineer, Pennsylvania Railroad, Altoona, Pa.

1907. VOIGHT, M. L. Superintendent of Shops, Borden's Condensed Milk Company, 952 De Kalb Avenue, Brooklyn, N. Y.

VOLLMER, WILLIAM (see *Standard Steel Works Company*).

1903. *VON SCHRENK, HERMANN. Von Schrenk, Fulks and Kammerer, Consulting Timber Engineers, Tower Grove and Fled Avenue, St. Louis, Mo.

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ELECTED.

1902. *VOORHEES, S. S. Engineer-Chemist, Bureau of Standards, Washington, D. C.

1903. *VREDENBURGH, WATSON, JR. Member, Hildreth and Company, Engineers, 17 Battery Place, New York, N. Y.

1909. WACLARK WIRE COMPANY. F. W. Wallace, Treasurer, 49 Wall Street, New York, N. Y.

1896. *WADDELL, J. A. L. Consulting Civil Engineer, 1012 Baltimore Avenue, Kansas City, Mo.

1908. WADLEIGH, F. R. Assistant General Manager, Chesapeake and Ohio Coal and Coke Company, Muncey Building, Washington, D. C.

1907. WADSWORTH, J. E. Resident Engineer, American Bridge Company, Hudson Terminal, 30 Church Street, New York, N. Y.

1904. WAGENHORST, JAMES H. General Manager, The United Rim Company, Akron, O.

1910. WAGNER, JOHN M. Purchasing Agent, Copper Range Railroad Company, Box 30, Houghton, Mich.

1899. *WAGNER, SAMUEL TOBIAS. Assistant Engineer, Philadelphia and Reading Railway, Huntingdon Street Station, Philadelphia, Pa.

1903. WAID, D. EVERETT. Architect, Madison Avenue, New York, N. Y.

1904. WALDO BROTHERS. 102 Milk Street, Boston, Mass.

1910. *WALDO, LEONARD. Consulting Engineer, 49 Wall Street, New York, N. Y.

1910. WALKER, H. F. Chief Chemist, Standard Steel Works Company, Box 598, Burnham, Pa.

1902. *WALKER, JOSEPH F. With Patton Paint Company, Newark, N. J. *For Mail:* 1431 Powell Street, Norristown, Pa.

1907. WALKER, PERCY H. Chief Chemist, Contracts Laboratory, Bureau of Chemistry, Washington, D. C.

1905. WALKER, WILLIAM H. Professor of Industrial Chemistry, Massachusetts Institute of Technology, 24 Trinity Place, Boston, Mass.

1910. *WALKER, W. R. Assistant to President, United States Steel Corporation, 71 Broadway, New York, N. Y.

1904. *WALLACE, E. C. 306 South Street, Jamaica Plains, Mass.

WALLACE, F. W. (see *Waclark Wire Company*).

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ELECTED.

1910. WALLACE, JOHN T. Vice-President, Blackmer and Post Pipe Company, 613 Wainwright Building, St. Louis, Mo.

1910. ‡WALLEDOM, JESSE J. 6717 Perry Avenue, Chicago, Ill.

1903. *WALTER, LEE W. Cement Inspector, Erie Railroad, Ninth and Provost Streets, Jersey City, N. J.

1908. WALTERS, HARRY E. Metallurgical Chemist, Lincoln Foundry Company, Sixtieth and Butler Streets, Pittsburg, Pa.

1903. WARNER, GEORGE C. Sullivan Machinery Company, Box 33, Claremont, N. H.

1905. WARREN BROTHERS COMPANY. 93 Federal Street, Boston, Mass.

1907. WASHBURN, FRANK E. Resident Engineer, St. Louis Electric Bridge Company, Salisbury and Hall Streets, St. Louis, Mo.

1904. *WASON, LEONARD C. President, Aberthaw Construction Company, 8 Beacon Street, Boston, Mass.

1911. WATERBURY, LESLIE A. Professor of Civil Engineering, University of Arizona, Tucson, Ariz.

1910. *‡WEBER, PETER J. City Chemist, City Hall, Milwaukee, Wis.

WEBSTER, FRANKLIN (see *Insurance Engineering*).

1900. *WEBSTER, GEORGE S. Chief Engineer and Surveyor, Bureau of Surveys, 318 City Hall, Philadelphia, Pa.

1898. *WEBSTER, WILLIAM R. (*Member of Executive Committee*). Civil Engineer, 411 Walnut Street, Philadelphia, Pa.

1909. *WEBSTER, WILLIAM R. General Superintendent, Bridgeport Brass Company, Bridgeport, Conn.

1906. WEEKS, PAUL. 217 Mariposa Avenue, Los Angeles, Cal.

1910. WEIL, I. Consulting Engineer, Farmers' Bank Building, Pittsburg, Pa.

1904. WENTWORTH, CHARLES C. Principal Assistant Engineer, Norfolk and Western Railway, Roanoke, Va.

1905. WENTZ, DANIEL B. President, Stonega Coal and Coke Company, 1723 Land Title Building, Philadelphia, Pa.

1897. WEST, THOMAS D. Foundry Expert, The West Steel Casting Company, 805 East Seventieth Street, Cleveland, O.

1909. WESTERN ELECTRIC COMPANY. G. Crossman, in charge of Inspection Branch, Engineering Department, 463 West Street, New York, N. Y.

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ELECTED.

1910. WESTERN UNION TELEGRAPH COMPANY. R. E. Chetwood, Engineer of Construction, 195 Broadway, New York, N Y.

1911. WESTESSEN, JOSEPH. Chemist, Naval Gun Factory, United States Navy Yard, Washington, D. C.

1909. *WESTINGHOUSE AIR BRAKE COMPANY. Harry C. Loudenbeck, Chief Chemist, Wilmerding, Pa.

1908. WESTINGHOUSE, CHURCH, KERR AND COMPANY. C. M. Chapman, Engineer-in-Charge, 10 Bridge Street, New York, N. Y.

1904. WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY. L. A. Osborne, Vice-President, Box 911, Pittsburg, Pa.

1907. WESTON, FREDERICK W. Standard Steel Works Company, 1982 Hudson Terminal Building, New York, N. Y.

1908. WEST VIRGINIA UNIVERSITY LIBRARY. Nathaniel L. Goodrich, Librarian, Morgantown, W. Va.

1910. WETHERILL, C. T. President, G. D. Wetherill and Company, 114 North Front Street, Philadelphia, Pa.

1911. WETHERILL, SAMUEL. Special Representative, C. M. Childs and Company, 99 John Street, New York, N. Y.

1906. WETTACH, CHARLES D. Secretary, W. W. Lawrence and Company, West Carson Street, Pittsburg, Pa.

1907. ‡WEYMOUTH, FREDERICK A. Engineer of Tests, Maryland Steel Company, Sparrows Point, Md.

1906. WHEELER, EDWARD J. Consulting Chemist, 79 Chapel Street, Albany, N. Y.

1905. WHINERY, S. Consulting Engineer on Pavements, Borough of Manhattan, 95 Liberty Street, New York, N. Y.

1908. WHIPPLE, GEORGE C. Consulting Engineer, 103 Park Avenue, New York, N. Y.

1909. WHITE, ALFRED H. Junior Professor of Chemical Engineering, University of Michigan, 933 Forrest Avenue, Ann Arbor, Mich.

1911. ‡WHITE, G. A. Superintendent, Electrical Laboratory, 155 Grant Avenue, Vandergrift, Pa.

1906. *WHITE, G. D. Manager, Patton Paint Company, Newark, N. J.

1909. WHITE AND COMPANY, J. G. C. D. Gray, Assistant Electrical Engineer, 43 Exchange Place, New York, N. Y.

1909. *‡WHITEHEAD, ALLEN O. Assistant Manager, The Whitehead Iron and Steel Company, Tredegar, Monmouthshire, England.

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ELECTED.

1911. ‡WHITMAN, HARRY G. Chemist, Carpenter and Anderson, 19 Kellogg Street, Grand Rapids, Mich.

1911. WHITTEMORE, H. L. Engineer of Tests, Watertown Arsenal, Watertown, Mass.

1898. *WICKHORST, MAX H. Engineer of Tests, Rail Committee, American Railway Engineering Association, 962 Monadnock Block, Chicago, Ill.

1908. WIDDICOMBE, R. A. Engineer, 5552 Lakewood Avenue, Edgewater Station, Chicago, Ill.

1906. WIELAND, CHARLES F. Consulting Engineer, 911 Mutual Saving Bank Building, San Francisco, Cal.

1911. WIESE, H. B. Purchasing Agent, Parkesburg Iron Company, Parkesburg, Pa.

1909. ‡WIG, RUDOLPH J. Assistant Engineer, United States Geological Survey, Bureau of Standards, Washington, D. C.

1909. ‡WIGHT, FRANK C. Associate Editor, *Engineering News*, 220 Broadway, New York, N. Y.

1910. *WILEY, CLARENCE N. Chief Chemist, Atlantic and Gulf Portland Cement Company, Drawer 111, Ragland, Ala.

1910. WILEY, W. O. Secretary, John Wiley and Sons, 43 East Nineteenth Street, New York, N. Y.

1902. WILHELM COMPANY, THE A. Paint Makers. Walter S. Davis, Secretary and Treasurer, Reading, Pa.

1898. WILLE, H. V. Assistant to Superintendent, Baldwin Locomotive Works, 500 North Broad Street, Philadelphia, Pa.

1908. ‡WILLIAMS, C. C. Assistant Professor of Civil Engineering, University of Colorado, 1313 Seventh Street, Boulder, Colo.

1908. WILLIAMS, HENRY J. Chemical Engineer, 161 Tremont Street, Boston, Mass.

1905. WILLIAMSON, SYDNEY B. Division Engineer, Pacific Division, Isthmian Canal Commission, Corozal, Canal Zone.

WILSON, E. B. (see *American Bureau of Inspection and Tests*).

1906. WILSON, EDWARD F. Chemist, Westmoreland Coal Company, Irwin, Pa.

1908. WILSON, PERCY H. Secretary, Association of American Portland Cement Manufacturers, 1232 Land Title Building, Philadelphia, Pa.

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ELECTED.

1906. *WINCHESTER REPEATING ARMS COMPANY. R. L. Penney, in charge of Physical Laboratory, New Haven, Conn.

1900. *WING, CHARLES B. Professor of Structural Engineering, Leland Stanford Junior University, Stanford University, Cal.

WINSLOW, R. S. (see *Clearfield Clay Working Company*).

WINSOR, PAUL (see *Boston Elevated Railway Company*).

1909. *‡WINT, RUFUS W. G. Chemist, care of Firth-Sterling Steel Company, Box 812, Washington, D. C.

1907. ‡WITHEY, MORTON OWEN. Assistant Professor of Mechanics, University of Wisconsin. *For Mail:* 1630 Madison Street, Madison, Wis.

1910. WITMER, FRANCIS P. Engineer in charge of Bridge Design, American Bridge Company, 30 Church Street, New York, N. Y.

1903. WITTMAN, N. B. Potts and Wittman, North American Building, Philadelphia, Pa.

1906. WOLF, OTTO C. Engineer and Architect, 511 Denckla Building, Philadelphia, Pa.

1903. *WOLFEL, PAUL L. Chief Engineer, McClintic-Marshall Construction Company, Rankin, Pa.

1908. WOOD, ALAN, 3D. Mechanical Engineer, Conshohocken, Pa.

1903. WOOD, EDWARD R., JR. Manufacturer, 400 Chestnut Street, Philadelphia, Pa.

1910. ‡WOOD, EDWIN T. Engineer of Tests, La Belle Iron Works, Steubenville, O.

1911. *‡WOOD, F. B. Engineer of Tests, Standard Roller Bearing Company, Fifty-fifth Street and Lancaster Avenue, Philadelphia, Pa.

1903. WOOD, F. W. President, Maryland Steel Company, Sparrows Point, Md.

1902. *WOOD AND COMPANY, R. D. Founders. Walter Wood, 400 Chestnut Street, Philadelphia, Pa.

WOOD, JOHN G. (see *International Harvester Company*).

1900. *WOOD, WALTER. Cast-Iron Pipe Manufacturer, R. D. Wood and Company, 400 Chestnut Street, Philadelphia, Pa.

1910. ‡WOODROFFE, G. H. Assistant Engineer of Tests, Baldwin Locomotive Works, 1 West Johnson Street, Germantown, Philadelphia, Pa.

WOODS, C. F. (see *Little, A. D., Incorporated*).

1906. WOODS, R. M. Chief Chemist, Northern Pacific Railway Company, General Office Building, St. Paul, Minn.

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ELECTED.

1906. WOODWELL, JULIAN E. Consulting Engineer, Terminal Building, Park Avenue and Forty-first Street, New York, N. Y.

1908. WOODWORTH, R. B. Engineer with Carnegie Steel Company, 427 Carnegie Building, Pittsburg, Pa.

1900. *WOOLSON, IRA H. Consulting Engineer, National Board of Fire Underwriters, 135 Williams Street, New York, N. Y.

1904. *WORCESTER, JOSEPH R. J. R. Worcester and Company, 79 Milk Street, Boston, Mass.

1905. WORCESTER POLYTECHNIC INSTITUTE. William W. Bird, Director of the Department of Mechanical Engineering, Worcester, Mass.

1904. WORMELEY, P. L., JR. Engineer of Tests, Division of Tests, United States Department of Agriculture, 3014 Dent Place, Washington, D. C.

WRIGHT, W. H. (see *Schenectady Varnish Company*).

1909. WULFETUNGE, J. F. Purchasing Agent, Riter-Conley Manufacturing Company, Pittsburg, Pa.

1910. WYER, M. G. Librarian, State University of Iowa, Iowa City, Iowa.

1906. *WYMAN AND GORDON COMPANY, THE. George F. Fuller, General Superintendent and Secretary, Worcester, Mass.

1909. *YAMAGUCHI, JUNNOSUKE. Director, Imperial Japanese Railways, Shimbashi, Tokio, Japan.

1910. ‡YEOMAN, RAY C. Professor of Civil Engineering, Valparaiso University, Box 274, Valparaiso, Ind.

1911. YEOMANS, LUCIEN I. Production Engineer, Sears, Roebuck and Company, Chicago, Ill.

1907. YOUNG, J. BERTRAM. Chemist, Philadelphia and Reading Railway Company, Reading, Pa.

1908. YOUNG, JOHN M. Dean of Engineering, University of Hawaii, Honolulu, T. H.

1905. YOUNG, JOHN P. General Manager, Youngstown Car Manufacturing Company, Youngstown, O.

1911. ‡YOUNG, ROBERT J. Assistant, Metallurgical Laboratory, Taylor Iron and Steel Company, Box 7, High Bridge, N. J.

1908. *†YOUNG, W. W. Consulting Engineer, 220 Broadway, New York, N. Y.

1907. *YOUNGSTOWN SHEET AND TUBE COMPANY. E. T. McCleary, Chief Chemist, Youngstown, Ohio.

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ELECTED.

1903. ZEHNDER, C. H. President, Alleghany Ore and Iron Company, 140 Cedar Street, New York, N. Y.

1911. *ZIMMERSCHIED, K. W. Metallurgical Engineer, General Motors Company, Detroit, Mich.

1908. *ZUERCHER, MAX A. Assistant Engineer, in charge of Rail, Switch and Frog Work, Canadian Pacific Railway, Bordeaux, Canada.

SUMMARY.

Total Membership	1,369
Total number holding membership also in the International Association for Testing Materials	492
Number of Life Members	2
Number of Junior Members	145

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DECEASED MEMBERS.

Name	Date of Membership.	Date of Death.
ALLIEN, VICTOR S.	1906	February, 1, 1908.
ANDERSON, J. W.	1896	May 18, 1905.
ATKINSON, EDWARD	1903	December, 11, 1905.
AUSTEN, P. T.	1906	December, 30, 1907.
BALDWIN, S. W.	1904	January, 5, 1910,
BARNSLEY, G. T.	1904	October 23, 1909.
BLACK, W. P.	1896	December 12, 1902.
BUDD, HENRY I.	1903	January 14, 1905.
CHRISTIE, JAMES	1898	August 24, 1911.
DROWN, THOMAS M.	1899	November 16, 1904.
DUDLEY, CHARLES B.	1896	December 21, 1909.
FRANKEL, HENRY U.	1903	December 8, 1903.
GOWEN, CHARLES S.	1904	October 19, 1909.
GRAY, THOMAS.	1896	February 12, 1909.
HALLETT, NELSON A.	1903	August 9, 1910.
HOOPER, A.	1908	December 28, 1909.
JARECKI, CHARLES.	1896	January 26, 1901.
JOHNSON, EDMUND.	1905	May 23, 1909.
JOHNSON, J. B.	1899	June 23, 1902.
JOHNSON, W. C.	1900	December 15, 1906.
KERNS, JOHN J.	1910	March 12, 1911.
LUDLOW, S. H.	1904	January 16, 1908.
MCCAULEY, G. M.	1898	May 25, 1901.
METCALF, WILLIAM	1903	December 5, 1909.
MORISON, GEORGE S.	1896	July 1, 1903.
MORTON, HENRY	1896	May 9, 1902.
MOULTON, MACE	1906	April 27, 1909.
PIERCE, D. H.	1907	July 1, 1909.
TATNALL, GEORGE	1906	September 13, 1906.
THURSTON, ROBERT H.	1896	October 25, 1903.
WARMAN, F. C.	1905	April 27, 1908.
WOODMAN, D.	1903	September 4, 1907.
WRIGHT, H. H.	1904	June 22, 1905.
WYMANN, W. H.	1905	November 11, 1905.

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GEOGRAPHICAL DISTRIBUTION OF MEMBERS.

ALABAMA.

Birmingham: A. W. Allen; F. H. Crockard; J. R. Harris; F. H. Lewis.

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Ragland: C. N. Wiley.

St. Stephens: O. Gerlach.

University: E. B. Kay.

ARIZONA.

Tucson: L. A. Waterbury.

CALIFORNIA.

Berkeley: A. C. Alvarez; C. Derleth, Jr.; C. G. Hyde; O. C. Merrill; H. Stillman.

Colton: W. C. Hanna.

Emeryville: D. Finley.

Hermosa Beach: G. Nelson.

Los Angeles: L. A. Dubbs; F. W. Huber; R. G. Osborne; A. F. Rosenheim; K. D Schwendener; P. Weeks.

Marysville: C. A. Trow.

Oakland: J. J. Donovan; B. S. Drake; H. M. Fitch.

San Francisco: W. A. Doble; W. H. George; Heller and Wilson; L. E. Hunt; R. E. Noble and Company; J. M. O'Hara; C. Paff; W. C. Riddell; Smith, Emery and Company; F. W. Tibbetts; C. F. Wieland.

Santa Cruz: L. T. Bachman.

Saratoga: A. A. M. Russell.

Stanford University: Leland Stanford Junior University; C. B. Wing.

West Berkeley: California Corrugated Culvert Company.

COLORADO.

Boulder: M. S. Ketchum; C. C. Williams.

Denver: J. Y. Jewett.

Fort Collins: L. G. Carpenter.

Pueblo: Colorado Fuel and Iron Company.

CONNECTICUT.

Ansonia: H. C. Jennison.

Bridgeport: Bridgeport Brass Company; A. P. Ford; E. S. Sperry; R. F. Stoddart; W. R. Webster.

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CONNECTICUT.—*Continued.*

Hartford: Hartford Steam Boiler Inspection and Insurance Company; H. Souther.

New Britain: W. I. Keeler; W. S. Rowland.

New Haven: B. S. Hinckley; W. H. Moore; Sheffield Scientific School Library; W. K. Shepard; Winchester Repeating Arms Company.

Stamford: A. H. Emery.

Suffield: R. E. Spaulding.

Waterbury: American Brass Manufacturing Company; E. O. Goss; H. L. Thompson.

West Haven: E. H. Raquet.

DELAWARE.

Wilmington: H. M. Barksdale; N. H. Davis; H. O. Duerr; E. W. Lazell; W. W. Lobdell.

DISTRICT OF COLUMBIA.

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GEORGIA.

Rockmart: J. L. Mack.

IDAHO.

Boise: A. P. Adair.

Moscow: C. N. Little.

ILLINOIS.

Aurora: W. A. Derby.

Champaign: H. F. Moore; J. O. Taylor.

Chicago: American Asphaltum and Rubber Company; American Bureau of Inspection and Tests; J. G. Bergquist; C. W. Boynton; Bradley and Vrooman Company; W. Brady; I. M. Bregowsky; J. Brunner; R. T. Brydon; F. O. Bunnell; J. M. Carmody; W. M. Carpenter; C. H. Cartlidge; Commonwealth-Edison Company; T. L. Condron; W. A. Converse; Crane Company; G. A. Damon; G. M. Davidson; J. C. Davis; A. deD. de Pierrefeu; R. C. Dudley; *Electrical Review and Western Electrican;* R. W. Evans; A. G. Fay; R. Forsyth; W. Forsyth; R. M. Gerety; H. Green; E. O. Greifenhagen; E. Gudeman; E. M. Hagar; P. B. Harrison;

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ILLINOIS.—*Continued.*

C. D. Hill; L. S. Hughes; R. W. Hunt and Company; H. C. Hutchins; Illinois Central Railroad Company; Illinois Steel Company; International Harvester Company; Interstate Iron and Steel Company; M. T. Jones; L. Kirschbraun; J. Lawrie; C. F. Loweth; H. Mannhardt; E. D. Martin; H. M. McCormack; W. Michaelis, Jr.; A. V. H. Mory; A. W. Moseley; H. W. Mudge; National Fireproofing Company; W. A. Nettleton; C. G. Osborne; S. Otis; C. E. Paul; H. D. Piper; *Railway and Engineering Review;* J. D. Ristine; Roberts and Schaefer Company; A. F. Robinson; *Rock Products;* J. T. Ryerson and Son; C. Scholz; E. C. and R. M. Shankland; J. S. Sheafe; W. C. Squires; Standard Asphalt and Rubber Company; Standard Screw Company; W. B. Storey, Jr.; C. L. Strobel; E. H. Taylor; I. Van Trump; F. K. Vial; J. J. Walledom; M. H. Wickhorst; R. A. Widdicombe; L. J. Yeomans.

Granite City: R. A. Bull; J. W. Mills.

Hawthorne: O. Linder.

La Salle: Marquette Cement Manufacturing Company.

Moline: D. H. Stacks.

Monmouth: A. W. Gates.

North Chicago: A. A. Baker.

Rock Island: F. E. Hobbs; D. M. King.

South Chicago: O. Eisenschiml.

Springfield: A. N. Johnson.

Urbana: D. A. Abrams; A. V. Bleininger; W. F. M. Goss; S. W. Parr; State Geological Survey; A. N. Talbot.

INDIANA.

Indianapolis: W. I. Ballentine; A. S. Bixby; W. P. Blair; J. R. Francis; E. B. Hall; H. E. Jordan; H. A. Schwartz.

Lafayette: A. E. Berdon; R. G. Dukes; J. W. Esterline; W. K. Hatt; A. P. Poorman; Purdue University Library; C. M. Smith.

Gary: W. C. Huntington; H. C. Thomas; J. B. Thorpe.

Portland: W. C. Hoover.

South Bend: Studebaker Library.

Terre Haute: W. P. Childs; M. A. Howe.

Valparaiso: R. C. Yoeman.

West Lafayette: H. H. Scofield.

IOWA.

Ames: A. O. Anderson; H. W. Gray; A. Marston.

Armstrong: P. H. Atwood.

Burlington: F. W. Salmon.

Des Moines: C. A. Rawson; J. Taylor.

Estherville: L. L. Bingham.

Iowa City: M. G. Wyer.

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KANSAS.

Iola: W. H. Klein.

Lawrence: C. I. Corp; H. Gardner; F. O. Marvin; H. A. Rice; University of Kansas, School of Engineering.

Mildred: P. W. Marx.

Topeka: G. W. Fiske; W. A. Powers.

KENTUCKY.

Earlington: J. B. Atkinson.

Newport: W. R. Fleming.

LOUISIANA.

New Orleans: G. J. Glover; Tulane University, Department of Experimental Engineering.

MAINE.

Orono: H. S. Boardman.

MARYLAND.

Annapolis: W. Cole; O. Z. Howard; F. Lyon; M. E. Reed; School of Marine Engineering Library.

Baltimore: Bartlett, Hayward and Company; B. F. Bush; A. T. Clark; F. H. Clark; O. C. Cromwell; W. W. Crosby; W. R. Edwards; J. E. Greiner; R. K. Meade; J. E. Muhlfeld; Penniman and Browne; E. K. Rothstein; C. P. Van Gundy.

Security: C. M. Goodman.

Sparrows Point: H. C. Lane; S. S. Martin; F. A. Weymouth; F. W. Wood.

MASSACHUSETTS.

Ashburnham: C. A. Hubbell.

Belmont: F. L. Murray.

Boston: E. G. Bailey; F. A. Barbour; P. Barker; Boston Elevated Railway Company; G. H. Brazer; F. N. Bushnell; E. A. Buss; W. M. Davis; H. P. Eddy; W. E. C. Eustis; H. Fay; F. W. Ferguson; C. E. Fuller; A. H. Gill; W. Goodenough; R. K. Hale; H. W. Hayward; J. O. Henshaw; C. J. Hogue; A. F. Holmes; W. A. Johnston; W. F. Kearns; E. N. Lake; E. S. Larned; A. D. Little, Incorporated; Lockwood, Greene and Company; C. L. Norton; R. H. Richards; J. G. Rote; P. P. Sharples; H. L. Sherman; H. J. Skinner; L. S. Smith; J. P. Snow; H. P. Talbot; Waldo Brothers; W. H. Walker; Warren Brothers Company; L. C. Wason; H. J. Williams; J. R. Worcester.

Brookline: H. F. Tucker.

Cambridge: H. M. Boylston; E. T. Davis; Harvard College Library; H. J. Hughes; L. J. Johnson; G. H. Perkins; A. Sauveur; G. F. Swain.

Canton: E. T. Newsome.

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Dedham: G. W. Coggeshall.
East Walpole: W. E. Sumner.
Everett: R. G. Morse.
Jamaica Plains: E. C. Wallace.
Lee: W. W. Maclay.
Malden: C. P. Price.
Merrimac: Eastern Hard Fibre Company.
New Bedford: T. B. Akin.
Newton Highlands: S. E. Thompson.
North Edgemont: E. L. Corthell.
Pittsfield: A. McK. Gifford; A. B. Hendricks, Jr.
Reading: A. N. Mansfield.
Southbridge: W. L. Oakden.
South Yarmouth: C. H. Davis.
Springfield: E. G. Brick; The Emerson Laboratory; L. S. Storrs.
Tufts College: Tufts College, Department of Engineering.
Watertown: H. L. Whittemore.
West Lynn: General Electric Company, Lynn Works.
Worcester: American Steel and Wire Company; J. W. Bishop Company; F. C. Elder; L. D. Granger; E. L. Hancock; G. S. McFarland; F. W. Roys; Worcester Polytechnic Institute; The Wyman and Gordon Company.
Wollaston: H. E. K. Ruppel.

MICHIGAN.

Ann Arbor: A. H. White.
Detroit: Aluminum Castings Company; J. W. Barbey; F. F. Beall; Berry Brothers, Limited; C. T. Bragg; The Detroit Testing Laboratory; D. M. Ferguson; General Motors Company; C. H. Jumper; A. W. Munsell; C. S. Neal; R. A. Plumb; D. T. Randall; W. H. Sellew; K. W. Zimmerschied.
East Lansing: J. A. Polson.
Grand Rapids: H. G. Whitman.
Houghton: J. M. Wagner.
Hubbell: J. B. Cooper; G. L. Heath.
Ironwood: B. W. Vallat.
Sault Ste. Marie: L. C. Sabin.
Union City: A. Lundteigen.

MINNESOTA.

Duluth: E. K. Coe; F. Cramer.
Minneapolis: F. C. Bestor; E. H. Brown; W. H. Cavanaugh; O. N. Trooien.
St. Paul: J. T. Stewart; D. Tissing; R. M. Woods.

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MISSISSIPPI.

University: A. M. Muckenfuss.

MISSOURI.

Columbia: A. L. Hyde; F. P. Spalding.
Independence: J. L. Mack.
Kansas City: W. S. Dickey; I. H. Fetty; G. H. Tefft; J. A. L. Waddell.
Rolla: E. R. Buckley.
St. Louis: W. M. Armstrong; Campbell Glass and Paint Company; A. W. Clark; E. H. Dyer; O. L. Garrison; N. B. Gregg; J. F. Hinckley; Hoyt Metal Company; A. L. Johnson; J. J. Kessler; S. S. Knight; A. E. Lindau; H. W. Lohmann; N. R. McLure; Missouri Pacific Railway Company; C. D. Purdon; F. S. Rice; E. J. Russell; C. D. Smith; E. O. Sweetser; City of St. Louis Testing Laboratory; R. M. Strong; J. L. Van Ornum; H. von Schrenk; J. T. Wallace; F. E. Washburn.

MONTANA.

Anaconda: Anaconda Copper Mining Company.
Bozeman: Montana College of Agriculture and Mechanic Arts.
Helena: W. Jordan, Jr.
Pony: W. W. Strange.

NEBRASKA.

Lincoln: G. R. Chatburn.
Omaha: D. O. Clark; W. F. Harriman; J. Hoffhine.
South Omaha: W. H. Low.

NEVADA.

Hazen: W. J. Card.
Reno: University of Nevada Library.

NEW HAMPSHIRE.

Clairmont: G. C. Warner.

NEW JERSEY.

Alpha: A. F. Gerstell.
Ampere: Crocker-Wheeler Company.
Atlantic City: United Paving Company.
Bayonne: J. L. Gray; T. T. Gray.
Boonton: R. W. Seabury.
Bound Brook: H. Abraham.
Burlington: W. R. Conard; J. A. Hayes.
Camden: Camden Forge Company; J. L. De Bertodano.

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Chrome: L. Addicks.

Gibbsboro: J. Lucas and Company.

High Bridge: J. H. Hall; J. M. Sherrerd; K. Taylor; R. J. Young.

Hoboken: F. L. Pryor; T. B. Stillman.

Jersey City: W. J. Corliss; Joseph Dixon Crucible Company; J. A. Munsell; A. H. Sawyer; L. W. Walter.

Mahwah: F. W. Sargent.

Maurer: C. N. Forrest.

Montclair: W. Kent; C. A. Mead.

Newark: B. L. Chandler; E. A. Condit; W. N. Hazen; R. E. Jennings; The Nairn Linoleum Company; J. Owen; T. P. Payne; M. Schreiber; M. R. Sherrerd; M. N. Shoemaker; G. D. White.

Perth Amboy: F. L. Antisell; J. C. Rossi; Standard Underground Cable Company.

Phillipsburg: W. R. Dunn.

Plainfield: F. Conlin; H. D. Hibbard; C. P. Karr.

Ridgefield Park: C. de Wyrall.

Stewartsville: H. E. Kiefer.

Trenton: H. C. Boynton; A. C. Gregory; J. A. Roebling's Sons Company.

Watchung: American Foundrymen's Association; R. Moldenke.

NEW YORK.

Albany: W. R. Davis; L. H. Dumary; R. S. Greenman; F. W. Kelley; J. E. Myers; G. P. Robinson; E. Touceda; E. J. Wheeler.

Bedford Hills: H. M. Howe.

Brooklyn: C. W. Aiken; W. H. Broadhurst; W. H. Chater; E. J. Fort; G. T. Hammond; A. Helwig; F. P. Ingalls; G. Kaufman; J. W. Masury and Son; J. P. Millwood; A. Rogers; H. Le H. Smith; G. W. Thompson; M. L. Voight.

Buffalo: W. M. Corse; Lackawanna Steel Company; R. W. Lindsay; F. W. Robinson; A. Schwarcman; F. M. Stapleton; The Titanium-Alloy Manufacturing Company.

Elmira: R. T. Lewis; O. Phillips.

Flushing: A. H. Sabin.

Glens Falls: International Paper Company.

Gloversville: G. Orr.

Hastings-upon-Hudson: G. P. Hemstreet.

Hoosick Falls: J. A. Beckett; S. C. Cluett.

Hudson: E. C. Champion; A. Neu.

Ilion: Remington Arms and Ammunition Company.

Ithaca: R. C. Carpenter; Cornell University Library.

Jamaica: O. Erlandsen.

Jamestown: J. R. Sanborn.

Laurel Hill: J. B. Herreshoff, Jr.

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Lockport: L. E. Howard.

New Brighton: J. F. Thompson.

Newburgh: E. Penny.

New York: H. H. Adams; J. K. Adams; A. Allen, Jr.; American Bridge Company; American Bureau of Shipping; American Electric Railway Engineering Association; American Railway Association; American Telephone and Telegraph Company; F. M. Andrews and Company; T. P. Armstrong; W. D. Arter; E. B. Ashby; C. V. Bacon; F. T. H. Bacon; H. C. Baird; Barrett Manufacturing Company; S. H. Bassett; W. N. Beach; B. Berger; A. Black; C. P. Bliss; Boller and Hodge; W. A. Bostwick; A. L. Bowman; O. Brainard; L. F. Braine; R. S. Buck; F. A. Burdett; W. H. Burr; W. Campbell; A. Carnegie; A. B. Chamberlin; F. P. Cheesman; M. E. Chester; S. R. Church; A. Churchward; E. A. S. Clarke; E. B. Cobb; T. I. Coe; W. T. Corbett; J. A. Church; W. C. Cuntz; J. V. Davies; C. Davis; J. F. Deemes; E. W. DeKnight; Detroit Graphite Company; F. W. Devoe and C. T. Raynolds Company; L. C. Dilks; J. Douglass; W. J. Douglass; A. W. Dow; J. S. Doyle; P. H. Dudley; B. W. Dunn; H. Dunning; T. Dwight; J. O. Eckersley; O. M. Eidlitz; Electrical Testing Laboratories; A. H. Elliott; F. A. Elmquist; *Engineering Record;* S. M. Evans; W. W. Ewing; M. S. Falk; A. Falkenau; F. M. Farmer; H. S. Fleming; A. E. Forstall; H. Fougner; G. L. Fowler; J. W. Frank; J. B. French; A. I. Frye; W. B. Fuller; R. H. Gaines; T. J. Gannon; M. Gay; J. Gayley; G. Gibbs; F. A. Goetze; E. P. Goodrich; A. R. Gormully; W. S. Gould; J. H. Gregory; A. B. Hager; C. W. Hall; S. Hamburger; C. S. Hamner; E. S. Hand; W. W. Havens; E. L. Heidenreich; R. Hering; C. E. Hermann; P. S. Hildreth; H. P. Hill; N. S. Hill, Jr.; H. B. Hodges; O. Hoff; J. L. Holst; A. C. Horn; O. E. Hovey; J. W. Howard; C. T. Hutchinson; *The Iron Age;* R. J. Jenks; R. E. Jennings; S. W. Jones; E. Jonson; H. Josias; J. L. Kemmerer; J. J. Kennedy; W. H. Kershaw; J. A. Kinkead; C. Kirchhoff; P. A. Kirchner; J. A. Knighton; G. F. Kunz; H. A. La Chicotte; C. G. E. Larsson; Ledoux and Company; J. H. Lidgerwood, Jr.; P. T. Lindhard; E. McL. Long; A. N. Lukens; J. S. Macgregor; W. Main; C. P. Marsh; H. McBurney; J. C. McGuire; P. C. McIlhiney; C. F. McKenna; E. D. Meier; C. Meriwether; M. Merriman; *The Metal Industry;* R. P. Miller; A. E. Mitchell; L. S. Moisseiff; G. E. Molleson; F. B. Morse; A. Moyer; W. Mueser; C. R. Myer; New Jersey Zinc Company; New York Central and Hudson River Railroad Company, Engineering Department; New York Fire Insurance Exchange; Orford Copper Company; G. A. Perley; A. Polk; L. R. Pomeroy; H. F. J. Porter; A. J. Provost, Jr.; Railway Steel Spring Company; Raymond Concrete Pile Company; M. Raymond; T. E. Rhodes; C. Richardson; L. D. Rights; A. E. Roberts; J. I. Rogers; W. B. Ruggles; M. E. Rupp; R. R. Rust; F. E. Schmitt; H. J. Schnell; F. Schniewind; A. W. Schwartz; C. E. Scribner; H. B. Seaman; Semet-Solvay Company;

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G. F. Shaffer; A. F. Shore; C. Shults; F. P. Smith; Society of Gas Engineering of New York; A. Sommer; H. Spencer; G. C. Stone; B. Stoughton; New York Technischer Verein; E. Thacher; M. Toch; C. Tomkins; H. C. Turner; F. F. Vandevort; Viele, Blackwell and Buck; W. Vredenburgh; Waclark Wire Company; J. E. Wadsworth; D. E. Waid; L. Waldo; W. R. Walker; Western Electric Company; Western Union Telegraph Company; Westinghouse, Church, Kerr and Company; F. W. Weston; S. Wetherill; S. Whinery; G. C. Whipple; J. G. White and Company; F. C. Wight; W. O. Wiley; F. P. Witmer; J. E. Woodwell; I. H. Woolson; W. W. Young; C. H. Zehnder.

Niagara Falls: F. A. J. FitzGerald; A. H. Hooker; International Acheson Graphite Company; A. H. Van Cleve.

Perry: R. W. How.

Potsdam: T. S. Clarkson Memorial School of Technology.

Richmond Hill: R. C. Strachan.

Rochester: Bausch and Lomb Optical Company; F. R. Baxter.

Schenectady: American Locomotive Company; J. A. Capp; H. E. Diller; General Electric Company; S. V. Hunnings; Schenectady Varnish Company.

Syracuse: H. C. Allen; W. H. Blauvelt; J. N. Bourg; W. B. Cogswell; L. N. Fenner; H. H. Franklin Manufacturing Company; W. J. Harvie; W. E. Hopton; J. A. Mathews; J. H. Nead; H. A. Pardee.

Tarrytown: I. E. Blumgardt.

Troy: T. R. Lawson; Ludlow Valve Manufacturing Company; J. W. Nugent; J. H. Spengler; G. S. Thompson.

Victor: The Locke Insulator Manufacturing Company.

West Albany: R. W. Mahon.

NORTH CAROLINA.

Canton: L. C. Buck.

Waynesville: J. W. Seaver, Jr.

Wilmington: W. A. Fisher.

NORTH DAKOTA.

University: University of North Dakota.

OHIO.

Akron: W. C. Geer; J. J. Starr; J. H. Wagenhorst.

Canton: E. A. Langenbach.

Cincinnati: F. W. Cherrington; Cincinnati Chapter, American Institute of Architects; Eagle White Lead Company; G. K. Elliott; Elzner and Anderson; R. Hockstetter; A. L. Jenkins; L. G. Robinson; H. Schneider; F. L. Swanberg.

Cleveland: H. B. Anderson; A. O. Backert; The Brown Hoisting Machinery Company; Case School of Applied Science, Department of

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Civil Engineering; R. Cathcart; W. T. Clark; The Cleveland Engineering Society; B. Crowell; H. F. Deverell; R. H. Fernald; E. W. Furst; D. Gaehr; F. A. Glidden; J. H. Herron; *The Iron Trade Review;* H. R. Kimmel; H. M. Lane; F. H. Neff; J. H. Nelson; The Osborn Engineering Company; F. J. Peck and Company; C. Schmidt; The Sherwin-Williams Company; H. E. Smith; O. Textor; G. H. Tinker; W. S. Tyler Company; T. D. West.

Collinwood: G. S. Chiles; T. F. Clay, Jr.; G. E. Doke.

Columbus: Burgess and Long; H. M. Bush; E. Orton, Jr.

Dayton: F. O. Clements; E. A. Deeds; A. Giesler; H. G. Kittredge; D. A. Kohr; The Lowe Brothers Company; The National Cash Register Company.

Elyria: C. M. Campbell.

Findlay: J. L. Child.

Mansfield: R. H. Arnold.

Middletown: J. A. Aupperle; W. J. Beck; R. B. Carnahan, Jr.; G. H. Charls; S. R. Rectanus.

Sandusky: S. B. Newberry.

Steubenville: E. T. Wood.

Superior: S. Smith.

Toledo: D. M. Luehrs.

Youngstown: H. B. McMaster; C. S. Robinson; J. P. Young; Youngstown Sheet and Tube Company.

OKLAHOMA.

Stillwater: J. L. Jones.

OREGON.

Corvallis: S. H. Graf.

Portland: D. D. Clarke; R. S. Edwards; W. R. Phillips.

PENNSYLVANIA.

Alequippa: S. G. Stafford.

Allentown: B. Enright; C. A. Matcham; E. B. McCready; H. A. Reninger; D. E. Ritter.

Altoona: W. O. Dunbar; A. W. Gibbs; W. F. Kiesel; G. B. Koch; P. Kreuzpointner; J. Lloyd; H. K. McCauley; M. E. McDonnell; E. D. Nelson; F. N. Pease; S. C. Potts; H. M. Ramsay; H. B. Rodman; A. S. Vogt.

Ambridge: T. J. Bateman; J. J. Boyle; A. J. Christie; G. F. Sparhawk.

Beaver Falls: Union Drawn Steel Company.

Bellevue: J. J. Kaylor.

Bethlehem: S. H. Ingberg; J. E. Leibfried.

Brackenridge: A. P. Scott.

Braddock: G. D. Chamberlain.

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Bryn Mawr: T. N. Ely.

Burnham: O. C. Skinner; Standard Steel Works Company; D. Thomas; H. F. Walker.

Butler: G. I. King.

Canonsburg: G. C. Schade.

Carbondale: A. P. Trautwein.

Catasauqua: J. W. Fuller; L. Peckitt; H. J. Seaman.

Chester: A. M. Comey; W. M. Page; Penn Steel Castings and Machine Company; W. Tassin.

Clearfield: Clearfield Clay Working Company.

Coatesville: Lukens Iron and Steel Company; H. Taggart.

Columbia: W. Jenkins, Jr.

Conshohocken: W. A. Cooper; A. Wood, 3d.

Crafton: J. S. Johnston.

Creighton: C. H. Kerr.

Du Bois: Buffalo, Rochester and Pittsburg Railway Company.

Duquesne: J. M. Camp; J. S. Unger.

Easton: B. F. Fackenthal, Jr.; F. Firmstone; Lafayette College Library; J. M. Porter; P. W. Shimer.

East Pittsburg: W. A. Bole; T. D. Lynch; C. E. Skinner.

Emporium: A. C. Blum.

Erie: A. Jarecki.

Franklin: P. H. Conradson.

Glenshaw: F. L. Garlinghouse.

Greensburg: J. P. Donohoe; W. F. Elwood.

Harrisburg: Central Iron and Steel Company; J. W. Hunter; A. S. McCreath and Son; C. J. Pretsch.

Homestead: J. H. Grose.

Irwin: E. F. Wilson.

Johnstown: Cambria Steel Company; E. F. Kenney; R. H. Noderer.

Kittanning: W. Gowie.

Latrobe: C. E. Corson; E. T. Edwards.

Lebanon: American Iron and Steel Manufacturing Company; C. J. Gadd.

Marcus Hook: J. H. Pew.

Masontown: H. E. Elson.

McKeesport: D. M. Buck; G. M. Goodspeed; J. M. Jeffers; J. A. McCulloch.

Munhall: D. L. Eynon; J. A. Henry; G. A. Hopkins; J. W. McGrady.

Nazareth: J. Brobston.

New Castle: United States Sherardizing Company.

Norristown: A. H. Fox; J. F. Walker.

Oakmont: J. L. Jones.

Packerton: Lehigh Valley Railroad Company.

Palmerton: G. Rigg.

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PENNSYLVANIA.—*Continued.*

Parkesburg: H. A. Beale; G. Thomas, 3d; H. B. Wiese.

Pencoyd: A. P. Hume; C. Major.

Philadelphia: H. C. Adams; G. Aertsen; W. A. Aiken; Ajax Metal Company; R. I. D. Ashbridge; Baldwin Locomotive Works; Barber Asphalt Paving Company; W. L. Batt; H. C. Berry; J. Birkinbine; A. Bonzano; Booth, Garrett and Blair; S. B. Bowen; J. W. Bramwell; H. DeH. Bright; J. G. Brown; R. P. Brown; W. C. Bullitt; A. M. Burnap; G. Butler; H. H. Campbell; E. Clark; C. H. Clifton; J. A. Colby; J. M. Cratty; H. C. Crawford; J. Dallas; G. C. Davies; Dodge, Day and Zimmerman; W. C. DuComb, Jr.; J. T. Fennell; L. R. Ferguson; T. Fisher; S. G. Flagg, Jr.; Franklin Institute; W. H. Fulweiler; Glasgow Iron Company; E. T. Greene; R. E. Griffith; H. L. Haldeman; W. H. Harding; H. J. Hartley; W. G. Hartranft; H. E. Hayward; W. W. Hearn; G. B. Heckel; M. E. Hibbs; R. W. Hilles; F. W. Hormann; Hughes and Patterson; R. L. Humphrey; J. R. Jones; R. K. Johnson; F. G. Kennedy, Jr.; L. H. Kenney; W. C. Kent; G. Lanza; R. W. Lesley; J. B. Lober; A. Lovell; E. Marburg; Midvale Steel Company; J. B. Miles; R. Mitchell; D. A. Morris; T. Olsen; T. Y. Olsen; A. E. Outerbridge, Jr.; A. M. Parkes; Pennsylvania Crusher Company; A. B. Perley; R. S. Perry; G. H. Pickard; M. M. Price; H. H. Quimby; W. B. Reinke; J. T. Richards; W. B. Riegner; F. A. Riehlé; C. D. Rinald; J. Royal; S. P. Sadtler and Son; C. C. Schneider; W. T. Sears; J. C. Sellers, Jr.; W. Sellers and Company, Incorporated; E. B. Smith; H. S. Spackman Engineering Company; H. W. Spangler; C. R. Spare; C. E. Stafford; A. A. Stevenson; J. G. Stevenson; C. M. Taylor; W. P. Taylor; J. C. Trautwine, Jr.; W. J. Tretch; United Gas Improvement Company; United States Cast Iron Pipe and Foundry Company; J. L. Vauclain; S. T. Wagner; G. S. Webster; W. R. Webster; D. B. Wentz; C. T. Wetherill; H. V. Wille; P. H. Wilson; N. B. Wittman; O. C. Wolf; E. R. Wood, Jr.; F. B. Wood; R. D. Wood and Company; W. Wood; G. H. Woodroffe.

Phœnixville: J. S. Deans.

Pittsburg: I. C. Allen; American Waterworks and Guarantee Company; J. A. Atwood; H. C. Barnes; P. H. Bates; A. W. Belden; L. H. Bowman; A. M. Brown; Brown and Company, Incorporated; Carnegie Institute, Civil Engineering Department; Carnegie Library; Carnegie Steel Company; Columbia Steel and Shafting Company; D. F. Crawford; A. E. Crockett; R. A. Cummings; W. C. Cushing; J. Dewar; B. Dewey; J. A. Dubbs; W. E. Emley; Engineers' Society of Western Pennsylvania; M. S. Evans; H. W. Fisher; S. B. Flagg; Follansbee Brothers Company; C. S. Foller; E. D. Frohman; H. F. Gilg; G. W. Greene; H. Gulick, Jr.; J. L. Haines; C. Hall; C. L. Hastings; C. W. Heppinstall; T. E. Hewitt; Heyl and Patterson, Incorporated; M. Hokanson; S. B. Howell; E. T. Ickes; W. G. Ireland; H. F. Jefferson; C. W. Johnson; Jones and Laughlin Steel Company; J. H. Jones; W. M. Kinney; E. S. Kniseley; M. Knowles; J. O. Leech; T. Lynch; F. M. Masters; J. B.

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PENNSYLVANIA.—*Continued.*

Masters; G. Matheson, Jr.; A. M. McCrea; J. McLeod; D. W. McNaugher; D. H. Murphy; National Tube Company; G. L. Norris; J. E. Ober; J. N. Ostrom; A. Pinkerton; Pittsburg Forge and Iron Company; Pittsburg Testing Laboratory; B. H. Rader; W. H. Rieger; C. M. Mills; S. M. Rodgers; F. Rose; C. F. W. Rys; B. Saklatwalla; G. W. Sargent; G W. Schluederberg; C. Shannon; J. J. Shuman; J. B. Sipe; C. V. Slocum; F. S. Slocum; J. H. Smith; H. L. Stitt; L. Stone; R. S. Suydam; E. Swensson; G. H. Taber; H. P. Tiemann; N. B. Trist; Union Steel Casting Company; University of Pittsburg; H. E. Walters; I. Weil; Westinghouse Electric and Manufacturing Company; C. D. Wettach; R. B. Woodworth; J. F. Wulfetunge.

Pittston: J. K. Griffith.

Pottstown: E. S. Cook.

Pottsville: A. G. Blakeley; W. H. H. Ginder.

Rankin: P. L. Wolfel.

Reading: The Carpenter Steel Company; L. J. Heizmann; Reading Iron Company; The A. Wilhelm Company; J. B. Young.

Ridgway: H. B. Norton.

Scranton: H. J. Force; J. M. Maris.

Sharon: W. G. Kranz; B. H. Pease.

South Bethlehem: Bethlehem Steel Company; R. M. Bird; A. L. Colby; H. E. Cook; H. S. Drinker; F. P. McKibben; J. W. Richards; F. E. Schall.

State College: Carnegie Library, Pennsylvania State College.

Steelton: H. B. Bent; F. D. Carney; J. W. Dougherty; L. B. Lindemuth; The Pennsylvania Steel Company; J. V. W. Reynders.

St. Marys: F. Oberkirch.

Vandegrift: A. H. Beale; H. L. Bodwell; R. G. Scott, Jr.; G. A. White.

Washington: F. M. Sanger, Jr.

West Pittsburg: N. W. Buch.

Wilkesbarre: Hazard Manufacturing Company.

Wilkinsburg: H. J. Lincoln.

Wilmerding: Westinghouse Air Brake Company.

York: C. H. Ehrenfeld.

RHODE ISLAND.

Phenix: F. J. Hoxie.

Providence: A. H. Blanchard; Brown and Sharpe Manufacturing Company; Brown University, Department of Mechanical Engineering; H. B. Drowne; E. F. Ely; J. R. Freeman; A. J. Loepsinger; W. M. Saunders; United States Gutta Percha Paint Company.

TENNESSEE.

Erwin: V. V. Kelsey.

Knoxville: J. A. Switzer.

Nashville: W. H. Schuerman.

South Pittsburg: W. H. Kewish.

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TEXAS.

El Paso: S. K. Simon.

UTAH.

Salt Lake City: E. H. Beckstrand; H. M. Jones; M. M. Murtaugh.

VIRGINIA.

Alexandria: J. C. Ramage.
Bedford City: E. D. Gregory.
Blacksburg: W. E. Barlow; J. S. A. Johnson; L. S. Randolph.
Fordwick: L. G. Sprague.
Fredericksburg: G. B. Strickler.
Norfolk: R. Bolling; A. S. Flowers; C. B. Shaffer; J. M. Umstadter.
Richmond: Froehling and Roberston; F. W. Scarborough.
Roanoke: C. S. Churchill; J. H. Gibboney; A. W. Lewis; L. C. Stewart; C. C. Wentworth.

WASHINGTON.

Baker: C. A. Newhall.
Seattle: Falkenburg and Laucks; A. H. Fuller; O. P. M. Goss; G. E. Hermann; J. K. Moore; R. H. Thomson.
Tacoma: F. T. Crowe and Company; E. O. Heinrich.

WEST VIRGINIA.

Ansted: W. N. Page.
Fairmont: F. R. Haas.
Morgantown: R. P. Davis; C. R. Jones; West Virginia University Library.
Wheeling: A. L. Bell; F. A. Browne.

WISCONSIN.

Ashland: Lake Superior Iron and Chemical Company.
Madison: C. F. Burgess; McG. Cline; E. R. Maurer; H. E. McKenzie; R. Thelen; F. E. Turneaure; M. O. Withey.
Mayville: A. F. Plock.
Milwaukee: H. S. Falk; C. E. Gage; S. A. Greeley; F. S. Low; R. S. MacPherran; Milwaukee Electric Railway and Light Company; L. Patton; G. N. Prentiss; P. J. Weber.
Racine: O. C. Friend.

WYOMING.

Laramie: J. C. Fitterer.

CANAL ZONE (PANAMA).

Corozal: S. B. Williamson.
Culebra: H. Goldmark; E. E. Lee; T. E. L. Lipscy; A. L. Robinson; E. Schildhauer.
Gatun: C. Harding.
Gorgona: J. H. Flynn, Jr.; B. D. Pender.

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HAWAIIAN ISLANDS.

Honolulu: F. G. W. Cooper; A. R. Keller; J. M. Young.

PHILIPPINE ISLANDS.

Manila: Bureau of Science.

AUSTRALIA.

Melbourne: H. Payne.
Sydney: A. Scheidel.

CANADA.

Bordeaux: M. A. Zurcher.
Dunnville: W. F. Scott.
Halifax: F. H. Sexton.
Hamilton: J. G. Morrow.
Montreal: W. F. Angus; E. Brown; J. A. DeCew; Dominion Bridge Company; The Duckworth-Boyer Engineering and Inspection Company, Limited; W. H. Ford; G. Giroux; T. S. Griffiths; M. L. Hersey; R. Job; H. O. Keay; H. M. Mackay; S. D. MacNab; McGill University Library; A. Stansfield.
Ottawa: G. E. Perley.
Port Colbone: S. R. Preston.
Sydney: J. P. McNaughton.
Tod Inlet: H. L. Knappenberger.
Toronto: B. E. Fernow; J. Galbraith; Robert W. Hunt Company, Limited; Smith, Kerry and Chace; R. H. Verity.
Vancouver: J. R. Grant; J. V. Nimmo.
Victoria: H. A. Ross.
Westmount: E. B. Tilt.
Winnipeg: H. B. Lake.

CUBA.

Havana: P. D. Buzzi; W. O'Malley.

ENGLAND.

London: R. Hawxhurst, Jr.; G. Magee, Jr.; L. S. Roberston; M. Ruthenburg; R. H. H. Stanger; E. Stuetz.
Sheffield: R. A. Hadfield.
Stoke-on-Trent: The English Ceramic Society.
Tredegar: A. O. Whitehead.

FRANCE.

Paris: L. H. Fry; A. S. Garfield; *Revue de Metallurgie.*

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GERMANY.

Dusseldorf: E. Schrodter.
Essen: F. Krupp Company.
Grand Duche de Luxembourg: L. Laval.

GUATEMALA.

Guatemala City: C. F. Novella.

JAPAN.

Tokio: J. Yamaguchi.

MEXICO.

Hidalgo: Cementos Hidalgo, S. A.

PORTO RICO.

San Juan: I. A. Canals.

RUSSIA.

Archangel: U. E Taubenheim.

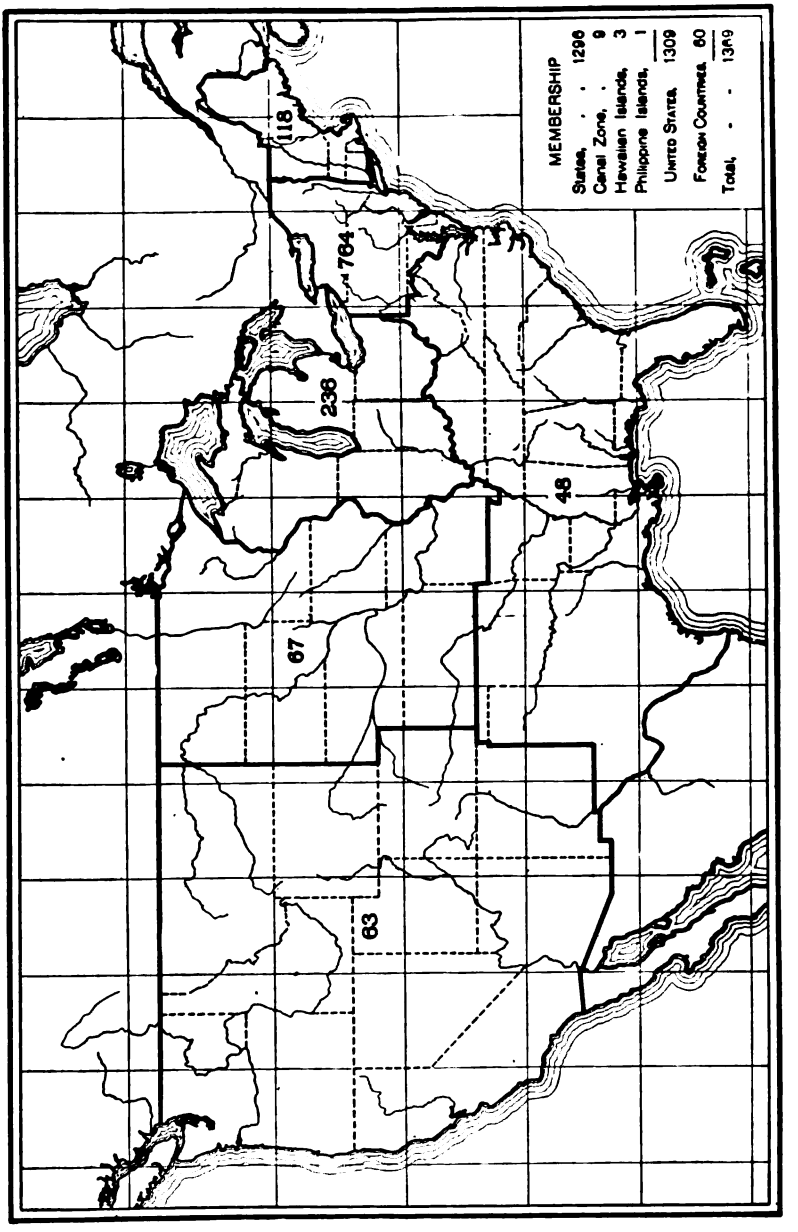
SOUTH AFRICA.

Johannesburg: Consolidated Goldfields of South Africa, Limited; Consolidated Goldfields of South Africa, Limited—Intelligence Department.

SPAIN.

Madrid: Laboratorio Central para el Ensayo de Materiales.

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Map showing the Geographical Distribution of the Membership of the American Society for Testing Materials.

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SUMMARY OF GEOGRAPHICAL DISTRIBUTION.

Alabama	8	Missouri	34	Wyoming	1
Arizona	1	Montana	4		
California	32	Nebraska	5	Canal Zone	9
Colorado	5	Nevada	2	Hawaiian Is.	3
Connecticut	21	New Hampshire	1	Philippine Is.	1
Delaware	5	New Jersey	53		
Dist. of Columbia	35	New York	292		
Georgia	1	North Carolina	3	Australia	2
Idaho	2	North Dakota	1	Canada	33
Illinois	99	Ohio	71	Cuba	2
Indiana	23	Oklahoma	1	England	9
Iowa	9	Oregon	4	France	3
Kansas	9	Pennsylvania	356	Germany	3
Kentucky	2	Rhode Island	10	Guatemala	1
Louisiana	2	Tennessee	4	Japan	1
Maine	1	Texas	1	Mexico	1
Maryland	23	Utah	3	Porto Rico	1
Massachusetts	85	Virginia	18	Russia	1
Michigan	24	Washington	9	South Africa	2
Minnesota	9	West Virginia	7	Spain	1
Mississippi	1	Wisconsin	19		

Membership in United States of America	1,309
Membership in Foreign Countries	60
Total Membership	1,369

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PAST OFFICERS.

The Society, from its organization in 1898 till its incorporation under its present name in 1902, was designated the American Section of the International Association for Testing Materials. The officers and members of the Executive Committee during this four-year period were as follows:

Chairmen:

MANSFIELD MERRIMAN, 1898–1900. HENRY M. HOWE, 1900–1902.

Vice-Chairmen:

HENRY M. HOWE, 1898–1900. CHARLES B. DUDLEY, 1900–1902.

Secretaries:

RICHARD L. HUMPHREY, 1898–1900. J. M. PORTER, 1900–1902.

Treasurers:

PAUL KREUZPOINTNER, 1898–1900. ROBERT W. LESLEY, 1900–1902.

Members of Executive Committee:

GUS. C. HENNING, 1898–1900. ALBERT LADD COLBY, 1900–1902.
MANSFIELD MERRIMAN, 1900–1902.

The past officers and members of the Executive Committee of the American Society for Testing Materials since its incorporation under that name in 1902, are as follows:

President:

CHARLES B. DUDLEY, 1902–1909.

Members of Executive Committee:

ALBERT LADD COLBY, 1902–1905. JOHN MCLEOD, 1902–1907.
JAMES CHRISTIE, 1902–1911.

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STANDING ADVISORY COMMITTEES.

On Iron and Steel.

William R. Webster, *Chairman.*

C. Kirchhoff, H. V. Wille.

On Cast Iron.

Henry Souther, *Chairman.*

Richard Moldenke, Thomas D. West.

On Cement and Concrete.

Clifford Richardson, *Chairman.*

Richard L. Humphrey, Spencer B. Newberry.

On Brick and Terra-cotta Products.

Edward Orton, Jr., *Chairman.*

H. O. Hofman, W. D. Richardson.

On Preservative Coatings.

G. W. Thompson, *Chairman.*

Robert Job S. S. Voorhees.

On Tests and Testing Apparatus.

Gaetano Lanza, *Chairman.*

Mansfield Merriman, Tinius Olsen.

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TECHNICAL COMMITTEES

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

A. FERROUS METALS.

COMMITTEE A-1, ON STANDARD SPECIFICATIONS FOR STEEL.

WILLIAM R. WEBSTER, *Chairman.*
A. A. STEVENSON, *Vice-Chairman.*
EDGAR MARBURG, *Secretary.*

NON-PRODUCERS (32).

American Locomotive Company, F. J. Cole.
American Electric Railway Engineering Association.
Baldwin Locomotive Works, H. V. Wille.
Beall, F. F.
Capp, J. A.
Cartlidge, C. H.
Churchill, Charles S.
Clark, F. H.
Colby, Albert Ladd.
Colby, J. Allen.
Deans, John Sterling.
Dudley, P. H.
General Motors Company, K. W. Zimmerschied.
Gormully, A. R.
Greiner, J. E.
Hartford Steam Boiler Inspection and Insurance Company, F. B. Allen.
Hunt and Company, Robert W.
Lynch, T. D.
Mahon, R. W.
Marburg, Edgar (*Secretary*).
Nelson, E. D.
Lanza, Gaetano.
Osborn Engineering Company, F. C. Osborn.
Pomeroy, L. R.
Richards, Joseph T.
Schneider, C. C.
Snow, J. P.
Souther, Henry.
Waddell, J. A. L.
Wagner, S. T.
Webster, William R. (*Chairman*).
Wickhorst, M. H.

PRODUCERS (25).

American Steel and Wire Company, F. H. Daniels.
American Steel Foundries, J. C. Davis.
Bethlehem Steel Company, E. O'C. Acker.
Cambria Steel Company, E. F. Kenney.
Carnegie Steel Company, C. F. W. Rys.
Central Iron and Steel Company, James B. Bailey.
Colorado Fuel and Iron Company, J. B. McKennan.
Illinois Steel Company, P. E. Carhart.
Jones and Laughlin Steel Company, Jesse J. Shuman.
Lackawanna Steel Company, F. E. Abbott.

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COMMITTEE A-1.—*Continued.*

PRODUCERS.—(*Continued.*)

Lukens Iron and Steel Company, Charles L. Huston.
Martin, S. S.
Mathews, John A.
McLeod, John.
Midvale Steel Company, Radclyffe Furness.
National Tube Company, Frank N. Speller.
Penn Steel Castings and Machine Company, Walter S. Bickley.
Pennsylvania Steel Company, J. V. W. Reynders.
Railway Steel Spring Company, A. S. Henry.
Reading Iron Company, George Schuhman.
Roebling's Sons Company, J. A., H. J. Horne.
Sargent, George W.
Slocum, F. S.
Standard Steel Works Company, A. A. Stevenson (*Vice-Chairman*).
Wood and Company, R. D., Walter Wood.

COMMITTEE A-2, ON STANDARD SPECIFICATIONS FOR WROUGHT IRON.

J. ALLEN COLBY, *Chairman.*
S. V. HUNNINGS, *Secretary.*

NON-PRODUCERS (8).

American Electric Railway Engineering Association.
American Locomotive Company, S. V. Hunnings (*Secretary*).
Baldwin Locomotive Works, H. V. Wille.
Colby, J. Allen (*Chairman*).
Gannon, Thomas J.
Snow, J. P.
Wickhorst, M. H.
Young, J. B.

PRODUCERS (7).

American Iron and Steel Manufacturing Company, J. P. Brock.
Beale, H. A., Jr.
Brown and Company, Incorporated, James Neale.
Glasgow Iron Company, J. P. Roe.
Hughes and Patterson, W. H. Hughes.
Pittsburg Forge and Iron Company, F. E. Richardson.
Reading Iron Company, George Schuhman.

COMMITTEE A-3, ON STANDARD SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

WALTER WOOD, *Chairman.*
RICHARD MOLDENKE, *Secretary.*

NON-PRODUCERS (26).

Beckett, James A.
Bramwell, Joseph W.
Colby, Albert Ladd.
Davidson, George M.
Diller, H. E.
Du Comb, W. C., Jr.
Fenner, L. M.
Findley, A. I.
Hatt, W. K.
Hildreth, P. S.

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COMMITTEE A-3.—*Continued.*

NON-PRODUCERS.—(*Continued.*)

Howe, Henry M.
International Harvester Company, John G. Wood.
Job, Robert.
Kinkead, J. A.
Kreuzpointner, Paul.
Lanza, Gaetano.
MacPherran, R. S.
McKenna, Charles F.
Merriman, Mansfield.
Moldenke, Richard (*Secretary*).
Outerbridge, Alexander E., Jr.
Saunders, Walter M.
Sauveur, Albert.
Souther, Henry.
Spangler, H. W.
Touceda, Enrique.

PRODUCERS (20).

*American Locomotive Company, S. V. Hunnings.
Colorado Fuel and Iron Company, J. B. McKennan.
Cook, Edgar S.
Fackenthal, B. F.
*Flagg, Stanley G.
*Hayes, J. A.
Hearne, W. W.
Henshaw, J. O.
*Illinois Steel Company, P. E. Carhart.
*Johnson, R. K.
*Jones and Laughlin Steel Company, Willis L. King.
*Lobdell, William W.
*Olsen, Tinius.
Peckitt, Leonard.
*West, Thomas D.
Wittman, N. B.
*Wood, E. R., Jr.
Wood, F. W.
*Wood, Walter (*Chairman*).
Zehnder, C. H.

COMMITTEE A-4, ON HEAT TREATMENT OF IRON AND STEEL.

HENRY M. HOWE, *Chairman.*

NON-PRODUCERS (5).

Campbell, William.
Howe, Henry M. (*Chairman*).
Sauveur, Albert.
Stansfield, Alfred.
Stoughton, Bradley.

PRODUCERS (4).

Bethlehem Steel Company, E. O'C. Acker.
Kenney, E. F.
Midvale Steel Company, Radclyffe Furness.
Unger, J. S.

COMMITTEE A-5, ON THE CORROSION OF IRON AND STEEL.

ALLERTON S. CUSHMAN, *Chairman.*
WILLIAM H. WALKER, *Secretary.*

NON-PRODUCERS (8).

Burgess, C. F.
Campbell, William.
Cushman, Allerton S. (*Chairman*).
Howe, Henry M.
Job, Robert.
Lyon, Frank.
Walker, William H. (*Secretary*).
Wickhorst, M. H.

* These members of Committee A-3, classed as PRODUCERS, stand in the relation of PRODUCER to certain products, and in that of NON-PRODUCER to other products within the province of the Committee

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COMMITTEE A-5.—*Continued.*

PRODUCERS (6).

Aupperle, J. A.
Buck, D. M.
Cooper, W. A.
Lukens Iron and Steel Company,
Charles L. Huston.
National Tube Company,
Frank N. Speller.
Rodgers, S. M.

COMMITTEE A-6, ON THE MAGNETIC TESTING OF IRON AND STEEL.

CHARLES W. BURROWS, *Chairman.*

Beck, W. J.
Capp, J. A.
Crocker-Wheeler Company,
R. B. Treat.
Esterline, J. W.
Follansbee Brothers Company,
J. G. Homan.
Linder, O.
Mathews, J. A.
Pinkerton, Andrew.
Sargent, G. W.
Scott, Arthur P.
Skinner, C. E.

COMMITTEE A-7, ON THE TEMPERING AND TESTING OF STEEL SPRINGS AND STANDARD SPECIFICATIONS FOR SPRING STEEL.

HENRY SOUTHER, *Chairman.*

NON-PRODUCERS (11).

Bunnell, F. O.
Bureau of Standards,
James E. Howard.
Davis, Nathan H.
Hunnings, S. V.
Kinkead, J. A.
Lanza, Gaetano.
Mahon, R. W.
Nelson, E. D.
Souther, Henry (*Chairman*).
Vauclain, J. L.
Wickhorst, M. H.

PRODUCERS (8).

American Steel Foundries,
J. C. Davis.
Bright, H. DeH.
Carnegie Steel Company,
Hugh P. Tiemann.
Carney, F. D.
Foller, Charles S.
Lukens, Alan.
McCrea, Archibald M.
Stevenson, A. A.

COMMITTEE A-8, ON STANDARD SPECIFICATIONS FOR COLD-DRAWN STEEL.

C. E. SKINNER, *Chairman.*

NON-PRODUCERS (6).

Capp, J. A.
National Cash Register Company,
F. O. Clements.
Remington Arms and Ammunition Company,
Nathan A. Chase.
Skinner, C. E. (*Chairman*).
Standard Screw Company,
E. H. Ehrman.
Winchester Repeating Arms Company,
R. L. Penney.

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COMMITTEE A-8.—*Continued.*

PRODUCERS (6).

American Steel and Wire Company, S. M. Rodgers.
Columbia Steel and Shafting Company, W. H. Martin.
Ickes, Elwood T.
Kenney, E. F.
Shuman, Jesse J.
Union Drawn Steel Company, F. N. Beegle.

COMMITTEE A-9, ON ALLOY STEELS.

HENRY M. HOWE, *Chairman.*
WILLIAM CAMPBELL, *Secretary.*

NON-PRODUCERS (8).

Bureau of Standards, W. F. Hillebrand.
Campbell, William (*Secretary*).
Howe, Henry M. (*Chairman*).
Norris, G. L.
Sauveur, Albert.
Skinner, C. E.
Souther, Henry.
Stoughton, Bradley.

PRODUCERS (7).

Carpenter Steel Company, J. H. Parker
Hall, John H.
Kenney, E. F.
Mathews, J. A.
Sargent, G. W.
Unger, J. S.
Zimmerschied, K. W.

COMMITTEE A-10, ON STANDARD SPECIFICATIONS FOR STAYBOLT IRON.

R. K. JOHNSON, *Chairman.*

NON-PRODUCERS (7).

Clark, F. H.
Harriman, N. F.
Hartford Steam Boiler Inspection and Insurance Company, F. B. Allen.
Hunnings, S. V.
Johnson, R. K. (*Chairman*).
Nelson, E. D.
Ramage, J. C.

PRODUCERS (2).

American Iron and Steel Manufacturing Company.
Brown and Company.

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B. NON-FERROUS METALS.

COMMITTEE B-1, ON STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

J. A. CAPP, *Chairman.*

NON-PRODUCERS (5).

General Electric Company, J. A. Capp (*Chairman*).
Viele, Blackwell and Buck, O. A. Havill.
Western Electric Company, G. Crossman.
Westinghouse Electric and Manufacturing Company, T. D. Lynch.
White and Company, J. G., C. D. Gray.

PRODUCERS (5).

American Brass Manufacturing Company, W. H. Bassett.
American Steel and Wire Company, J. F. Tinsley.
Roebling's Sons Company, J. A., H. J. Horne.
Standard Underground Cable Company, C. C. Baldwin.
Waclark Wire Company, F. W. Wallace.

COMMITTEE B-2, ON NON-FERROUS METALS AND ALLOYS.

WILLIAM CAMPBELL, *Chairman.*

Vice-Chairmen.

W. H. BASSETT T. D. LYNCH
G. H. CLAMER W. R. WEBSTER

NON-PRODUCERS (12).

Bragg, C. J.
Bureau of Standards, W. F. Hillebrand.
Bureau of Steam Engineering, L. A. Kriser.
Campbell, William (*Chairman*).
Capp, J. A.
Harriman, N. F.
Jones, Jesse.
Lynch, T. D. (*Vice-Chairman*).
Metal Industry, The J. L. Krom.
Smith, H. E.
Souther, Henry.
Sperry, E. S.

PRODUCERS* (15).

Addicks, L.
Ajax Metal Company, G. H. Clamer (*Vice-Chairman*).
American Brass Company, W. H. Bassett (*Vice-Chairman*)
Antisell, F. L
Corse, W. M.
Cooper, J. B.
Furst, E. W.
Goss, E. O.
Herreshoff, J. B., Jr.
Norris, G. L.
Spare, C. R.
Stone, G. C.
Thompson, G. W.
Thompson, J. F.
Webster, W. R. (*Vice-Chairman*).

*The members of Committee B-2, classed as PRODUCERS, stand in the relation of PRODUCER to certain products, and in that of NON-PRODUCER to other products within the province of the Committee.

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C. CEMENT AND CLAY PRODUCTS.

COMMITTEE C-1, ON STANDARD SPECIFICATIONS FOR CEMENT.

GEORGE F. SWAIN, *Chairman.*
GEORGE S. WEBSTER, *Vice-Chairman.*
RICHARD L. HUMPHREY, *Secretary.*

NON-PRODUCERS (17).

Booth, Garrett and Blair.
Cosby, Spencer.
Dow, A. W.
Hoff, Olaf.
Humphrey, Richard L. (*Secretary*).
Lewis, F. H.
Maclay, W. W.
McKenna, Charles F.
Munsell, A. W.
Porter, J. Madison.
Richards, Joseph T.
Richardson, Clifford.
Sabin, L. C.
Spackman Engineering Company, Henry S. Spackman.
Swain, George F. (*Chairman*).
Voorhees, S. S.
Webster, George S. (*Vice-Chairman*).

PRODUCERS (10).

Boynton, C. W.
Dumary, L. Henry.
Gerstell, A. F.
Hagar, Edward M.
Harding, W. H.
Lesley, Robert W.
Lober, John B.
Matcham, Charles A.
Newberry, Spencer B.
Seaman, Harry J.

COMMITTEE C-2, ON REINFORCED CONCRETE.

F. E. TURNEAURE, *Chairman.*
ROBERT W. LESLEY, *Vice-Chairman.*
RICHARD L. HUMPHREY, *Secretary.*

NON-PRODUCERS (13).

Fuller, W. B.
Heidenreich, E. Lee.
Humphrey, Richard L. (*Secretary*).
Lanza, Gaetano.
Marburg, Edgar.
Mills, C. M.
Moisseiff, Leon S.
Quimby, H. H.
Taylor, W. P.
Thompson, S. E.
Turneaure, F. E. (*Chairman*).
Wagner, Samuel T.
Webster, George S.

PRODUCERS (2).

Johnson, A. L.
Lesley, Robert W. (*Vice-Chairman*).

COMMITTEE C-3, ON STANDARD SPECIFICATIONS FOR PAVING AND BUILDING BRICK.

A. V. BLEININGER, *Chairman.*
E. W. LAZELL, *Secretary.*

NON-PRODUCERS (8).

Bleininger, A. V. (*Chairman*).
Douty, D. E.
Lawson, T. R.
Lazell, E. W. (*Secretary*).
Orton, Edward, Jr.
Talbot, Arthur N.
Testing Laboratory, City of St. Louis, Mont Schuyler.
Woolson, Ira H.

PRODUCERS (2).

Blair, Will P.
Duerr, H. O.

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COMMITTEE C-4, ON STANDARD SPECIFICATIONS AND TESTS FOR CLAY AND CEMENT SEWER PIPES.

RUDOLPH HERING, *Chairman.*
A. J. PROVOST, JR., *Vice-Chairman.*
E. J. FORT, *Secretary.*

NON-PRODUCERS (14).

Barbour, F. A.
Bleininger, A. V.
Eddy, Harrison P.
Fort, E. J. (*Secretary*).
Hering, Rudolph (*Chairman*).
Hill, C. D.
Howe, Malverd A.
Humphrey, Richard L.
Marston, A.
Provost, A. J., Jr. (*Vice-Chairman*).
Talbot, A. N.
Testing Laboratory, City of St. Louis,
Mont Schuyler.
Thompson, R. H.
Webster, George S.

PRODUCERS (6).

Kaufman, Gustave.
Meriwether, Coleman.
Oberkirch, Frank.
Rossi, James C.
Starr, John J.
Wallace, John T.

COMMITTEE C-5, ON FIREPROOFING MATERIALS.

IRA H. WOOLSON, *Chairman.*
R. P. MILLER, *Secretary.*

Ewing, W. W.
Freeman, John R.
Hodge, H. W.
Macgregor, J. S.
Sommerville, C. W.
Thacher, Edwin.
Waid, D. E.

COMMITTEE C-6, ON STANDARD TESTS AND SPECIFICATIONS FOR DRAIN TILE.

A. MARSTON, *Chairman.*

NON-PRODUCERS (8).

Chatburn, George R.
Fortier, Samuel.
Hering, Rudolph.
Marston, A. (*Chairman*).
Stewart, J. T.
Talbot, Arthur N.
Testing Laboratory, City of St. Louis,
Mont Schuyler.
Turneaure, F. E.

PRODUCERS (8).

Atwood, P. H.
Bingham, L. L.
Boynton, C. W.
Child, J. Leo.
Gates, A. W.
Hoover, W. C.
National Association of Cement Users,
Richard L. Humphrey.
Rawson, Charles A.

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D. MISCELLANEOUS MATERIALS.

COMMITTEE D-1, ON PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

S. S. VOORHEES, *Chairman.*
G. B. HECKEL, *Vice-Chairman.*
G. W. THOMPSON, *Secretary.*

NON-PRODUCERS (27).

Aiken, W. A.
Akin, Thomas B.
Boughton, E. W.
Cushman, Allerton S.
Davidson, George M.
Froehling and Roberston, Andrew Robertson.
Gardner, Henry A.
Gibboney, James H.
Gill, A. H.
Hume, A. P.
Job, Robert.
Macnichol, Charles.
McIlhiney, P. C.
Millwood, J. P.
Ramage, J. C.
Rogers, Allen.
Sadtler and Son, S. P.
Smith, F. P.
Smith, H. E.
Tassin, Wirt.
Van Gundy, C. P.
Voorhees, S. S. (*Chairman*).
Walker, Percy H.
Walker, William H.
Westinghouse, Church, Kerr and Company, C. M. Chapman.
Wickhorst, M. H.
Young, J. B.

PRODUCERS (26).

Campbell Paint and Glass Company, F. A. Lane.
Dixon Crucible Company, M. MacNaughton.
Eisenschiml, Otto.
Evans, S. M.
Forrest, C. N.
Glidden, F. H.
Heckel, G. B. (*Vice-Chairman*).
Ingalls, F. P.
Kohr, D. A.
Lindsay, R. W.
Low, Frank S.
Lowe Brothers Company, Houston Lowe.
Mannhardt, H.
Neal, C. S.
Perry, R. S.
Pickard, Glenn H.
Polk, Anderson.
Rigg, G.
Sabin, A. H.
Sherwin-Williams Company, E. C. Holton.
Toch, Maximilian.
Thompson, G. W. (*Secretary*).
United States Gutta Percha Paint Company, Herbert W. Rice.
Walker, Joseph F.
White, G. D.
Wilhelm Company, The A., Walter S. Davis.

COMMITTEE D-2, ON STANDARD TESTS FOR LUBRICANTS.

A. H. GILL, *Chairman.*
J. M. JEFFERS, *Secretary.*

NON-PRODUCERS (8).

Converse, W. A.
Davis, W. M.
Dow, A. W.
Gill, A. H. (*Chairman*).
Hume, A. P.
Jeffers, J. M. (*Secretary*).
Nelson, E. D.
Stratton, S. W.

PRODUCERS (6).

Conradson, P. H.
Gray, J. L.
Gray, T. T.
Penniman and Browne, A. L. Browne.
Pew, J. H.
Taber, George H.

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COMMITTEE D-3, ON STANDARD METHODS OF ANALYSIS OF FATS AND OILS.

C. N. FORREST, *Chairman.*

Frank, Jerome W.
Thompson, G. W.

COMMITTEE D-4, ON STANDARD TESTS FOR ROAD MATERIALS.

LOGAN WALLER PAGE, *Chairman.*
PRÉVOST HUBBARD, *Secretary.*

NON-PRODUCERS (15).

Blanchard, A. H.
Broadhurst, W. H.
Crosby, W. W.
Dow, A. W.
Greenman, R. S.
Hatt, W. K.
Holmes, J. A.
Hubbard, Prévost (*Secretary*).
Hunter, Joseph W.
Johnson, Arthur N.
Marston, A.
Page, Logan Waller (*Chairman*).
Richardson, Clifford.
Smith, F. P.
Spencer, Herbert.

PRODUCERS (13).

American Asphaltum and Rubber Company,
H. B. Pullar.
Chamberlain, A. B.
Cobb, E. B.
Forrest, C. N.
Fulweiler, W. H.
Hemstreet, G. P.
Kershaw, W. H.
Sommer, Albert.
Sharples, P. P.
Standard Asphalt and Rubber Company,
W. A. Levering.
Tomkins, Calvin.
United Gas Improvement Company,
W. H. Gartley.
Warren Brothers Company,
A. E. Schutte.

COMMITTEE D-5, ON STANDARD SPECIFICATIONS FOR COAL.

J. A. HOLMES, *Chairman.*
B. F. BUSH, *Secretary.*

NON-PRODUCERS (32).

Bailey, Edwin G.
Belden, A. W.
Blauvelt, W. H.
Brady, William.
Bush, B. F. (*Secretary*)
Capp, J. A.
Carney, F. D.
Deemes, J. F.
Dougherty, P. L.
Fernald, R. H.
Forstall, Alfred E.
Gibbs, A. W.
Goodenough, Walter.
Goss, W. F. M.
Hagar, Edward M.
Harris, J. R.
Holmes, J. A. (*Chairman*).
Hume, A. P.
Lesley, Robert W.
Moldenke, Richard.
Orton, Edward, Jr.
Parr, S. W.
Randall, O. T.
Rice, George S.
Roberts and Schaefer Company,
Frank E. Mueller.

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COMMITTEE D-5.—*Continued.*

NON-PRODUCERS.—*Continued.*

Robinson, C. S.
Storrs, L. S.
Taylor, Edward H.
United Gas Improvement Company, Walton Clark.
Voorhees, S. S.
White, Alfred H.
Woodwell, J. E.

PRODUCERS (17).

Adams, H. C.
Atkinson, John B.
Bullitt, W. C.
Clark, Dyer O.
Fisher, Thomas.
Fleming, Henry S.
Garrison, O. L.
Haas, Frank R.
Jones, John H.
Kemmerer, John L.
McCreath and Son, Andrew S., Andrew S. McCreath.
Mitchell, Robert.
Schleuderberg, G. W.
Scholz, Carl.
Toulmin, Priestley.
Wadleigh, F. R.
Winder, John.

COMMITTEE D-6, ON STANDARD SPECIFICATIONS FOR COKE.

C. H. ZEHNDER, *Chairman.*
ALBERT LADD COLBY, *Secretary.*

NON-PRODUCERS (15).

Anaconda Copper Mining Company, E. P. Mathewson.
Belden, A. W.
Blauvelt, W. H.
Bole, William A.
Colby, Albert Ladd (*Secretary*).
Cook, Edgar S.
Fackenthal, B. F., Jr.
Haldeman, Horace L.
Holmes, J. A.
Johnson, R. K.
Lynch, T. D.
Moldenke, Richard.
Souther, Henry.
Wittman, N. B.
Wood, Walter.

PRODUCERS (9).

Donohoe, John P.
Haas, Frank R.
Lloyd, John.
Lynch, Thomas.
Page, W. N.
Rothstein, E. K.
Schniewind, F.
Wentz, Daniel B.
Zehnder, C. H. (*Chairman*).

COMMITTEE D-7, ON STANDARD SPECIFICATIONS FOR THE GRADING OF STRUCTURAL TIMBER.

HERMANN VON SCHRENK, *Chairman.*

NON-PRODUCERS (7).

Elzner, A. O.
Fernow, B. E.
Lohmann, H. W.
Robinson, A. F.
Rosenheim, A. F.
Russell, E. J.
Von Schrenk, Hermann (*Chairman*).

PRODUCERS (1).

Fetty, I. H.

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COMMITTEE D-8, ON WATERPROOFING MATERIALS.

W. A. AIKEN, *Chairman.*
C. DE WYRALL, *Secretary.*

NON-PRODUCERS (9).

Aiken, W. A. (*Chairman*).
Davies, J. V.
DeWyrall, C. (*Secretary*).
Force, H. J.
Gaines, R. H.
Munsell, A. W.
Schreiber, Martin.
Walter, L. W.
Westinghouse, Church, Kerr and Company,
C. M. Chapman.

PRODUCERS (6).

Barrett Manufacturing Company,
W. S. Babcock.
Church, S. R.
DeKnight, E. W.
Standard Asphalt and Rubber Company,
W. H. Lawrence.
Toch, Maximilian.
Warren Brothers Company,
A. E. Schutte.

COMMITTEE D-9, ON STANDARD TESTS OF INSULATING MATERIALS.

C. E. SKINNER, *Chairman.*

NON-PRODUCERS (6).

Bureau of Standards,
H. B. Brooks.
Commonwealth-Edison Company,
E. O. Schweitzer.
Electrical Testing Laboratories,
F. M. Farmer.
General Electric Company,
J. A. Capp.
Skinner, C. E. (*Chairman*).
Western Electric Company,
G. Crossman.

PRODUCERS (4).

Geer, William C.
Locke Insulator Company,
Walter T. Goddard.
Schenectady Varnish Company,
W. H. Wright.
Standard Underground Cable Company,
H. W. Fisher.

COMMITTEE D-10, ON STANDARDIZING EXPLOSIVES.

C. E. MUNROE, *Chairman.*

NON-PRODUCERS (3).

Dunn, B. W.
Holmes, J. A.
Munroe, C. E. (*Chairman*).

PRODUCERS (3).

Barksdale, H. N
lum, A. C
Fay, A. G.

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E. MISCELLANEOUS SUBJECTS.

COMMITTEE E-1, ON STANDARD METHODS OF TESTING.

GAETANO LANZA, *Chairman.*

Bostwick, W. A.
Cambria Steel Company, G. E. Thackray.
Campbell, William.
Chamberlain, G. D.
Deans, John S.
Diller, H. E.
Fay, Henry.
Hatt, W. K.
Howard, J. E.
Howe, Henry M.
Hume, A. P.
Humphrey, Richard L.
Job, Robert.
Linder, O.
Merriman, Mansfield.
Moldenke, Richard.
Nelson, E. D.
Talbot, H. P.
Vauclain, J. L.
Woolson, Ira H.

COMMITTEE E-2, ON UNIFORM SPECIFICATIONS FOR BOILERS.

E. D. MEIER, *Chairman.*

NON-PRODUCERS (5).

Carpenter, R. C.
Hartford Steam Boiler Inspection and Insurance Company, F. B. Allen.
Hartley, H. J.
Johnson, R. K.
Meier, E. D. (*Chairman*)

PRODUCERS (2).

McLeod, John.
Lukens Iron and Steel Company, Charles L. Huston.

COMMITTEE E-3, ON THE DEFINITION OF THE TERM "MODULUS OF ELASTICITY" IN ITS APPLICATION TO MATERIALS, INCLUDING NON-FERROUS METALLIC METALS AND THEIR COMBINATIONS.

LEONARD WALDO, *Chairman.*

Howard, James E.
Whittemore, H. L.

COMMITTEE E-4, ON METHODS OF SAMPLING AND ANALYSIS OF COAL.

(Forming part of a joint committee on this subject with a committee of the American Chemical Society.)

Haas, Frank R.
Parr, S. W.
Voorhees, S. S.

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REGULATIONS GOVERNING TECHNICAL COMMITTEES.

Creation.—The creation of a technical committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

Appointments.—Appointments on technical committees shall be made by the Executive Committee subject to the following provisions:

1. On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of consuming and producing interests; or the former may be allowed to predominate with the acquiescence of the latter. Unattached experts shall be classed with the representatives of consuming interests.
2. Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.
3. Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

Preliminary Organization.—The President of the Society will appoint the chairman *pro tem.* of a new committee from the representatives of the consuming interests and unattached experts. The chairman *pro tem.*, after communicating with the other members of the committee, will fix the place and time of the first meeting. He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to economize time at the meeting and to afford a definite basis for discussion.

Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of consuming interests and unattached experts, and such other officers and sub-committees as the committee may desire. The duties

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and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

Reports.—The reports of technical committees shall be presented at the annual meetings. Reports embodying any features on which specific action on the part of the Society is recommended by the committee, must first have been submitted to letter ballot of the committee, and such features must have received the approval of the majority of those voting. Dissenting members shall have the right to present minority reports individually or jointly.

Specifications.—Proposed new and standard specifications or the proposed amendment of existing specifications must originate in the particular committee within whose province such specifications properly belong. No action affecting specifications shall be taken by any technical committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendations affecting specifications presented by the appropriate committees at the annual meetings of the Society may be amended by a majority vote of those voting, and the final adoption of new or amended specifications shall be subject to the following procedure:

1. Approval at an annual meeting by two-thirds vote of those voting.
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

Cooperation with Other Committees.—A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.

A committee desiring to bring about the appointment of similar committees by other societies for purposes of cooperation shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the

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desired end shall be conducted on behalf of the Executive Committee by the Secretary of the Society.

Publications.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

Current Expenses.—The current expenses of committees for stationery and postage will be assumed by the Society. Stationery of standard form will be furnished by the Secretary of the Society on application of the chairman or secretary of a committee. Expenses for postage will be paid by the Treasurer of the Society on vouchers approved by the chairman of a committee.

Extraordinary Expenses.—Expenses for items other than stationery and postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus collected shall be transmitted to the Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Treasurer of the Society. Payments for such purposes shall be made by the Treasurer of the Society only on vouchers approved by the chairman of the committee concerned.

Discharge of Committees.—Technical committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed or in consequence of protracted inactivity.

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THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

OFFICERS.

Acting President.

HENRY M. HOWE.

Vice-Presidents.

A. MARTENS. N. BELELUBSKY.

MEMBERS OF COUNCIL.

Every country having a membership of twenty or more in the Association is entitled to a representative on the Council. For those having a membership of less than twenty, mandataries are appointed by the Council.

Life Members.

FRANZ BERGER. ALEXANDER FOSS.

Elected Members.

Australia—W. H. WARREN.
Austria—B. KIRSCH.
Belgium—A. GREINER.
Denmark—H. I. HANNOVER.
France—A. MESNAGER.
Germany—A. MARTENS.
Great Britain—G. C. LLOYD.
Holland—L. BIENFAIT.
Hungary—A. REJTŐ.
Italy—S. CANEVAZZI (*pro tem.*).
Norway—S. A. LUND.
Roumania—C. M. MIRONESCO.
Russia—N. BELELUBSKY.
Spain—J. MARVA Y. MAYER.
Sweden—J. O. ROOS AF HJELMSÄTER.
Switzerland—F. SCHÜLE.
United States of America—HENRY M. HOWE.

MANDATARIES.

Canada—MILTON HERSEY.
Finland—A. GRANFELT.
Japan—D. SITO.
Luxembourg—E. BIAN.
Portugal—J. DA P. CASTANHEIRO DAS NEVES
Servia—M. MILASINOVIC.

General Secretary.

ERNST REITLER.
Nordbahnstrasse 50, Vienna, II, Austria.

Communications for the International Association should be directed to the International Association for Testing Materials, Nordbahnstrasse 50, Vienna, II, Austria.

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THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

BY-LAWS.

Adopted at the Budapest Congress, 1901.
Amended at the Brussels Congress, 1906, and at the Copenhagen Congress, 1909.

SECTION 1. The Association shall be called "THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS."

SEC. 2. The objects of the Association are: the development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for this purpose.

These objects will be furthered:

1. By the Congresses and other meetings of the Association.
2. By the publication of an official Journal.
3. By any other means that may appear desirable.

SEC. 3. The funds necessary for carrying out the purposes mentioned in Section 2 will be raised by

1 The annual subscriptions of members.
2. Profits from the official Journal.
3. Other contributions.

SEC. 4. Any person can become a member upon being proposed by two members of the Association.

Official bodies and technical societies can enter direct on their sending in their application for membership.

Applications for membership must be sent in writing to the President or to a member of the Council.

Resignations of membership must also be sent in the same way.

SEC. 5. It is the duty of every member to further the interests of the Society to the best of his ability.

Every member is required to pay an annual subscription of at least 8 Mks. =8 shillings = $2.00.*

* Subscriptions are to be paid to the duly appointed collectors in each country, the card of membership serving as a receipt. Subscriptions not paid by the first of July are collected through the post-office.

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The Council is authorized to increase the annual subscription in order to cover extraordinary expenses incurred in the interests of the Association.

SEC. 6. Every member has the right to obtain the "Proceedings" of the Association, during the period for which his subscription has been paid.

SEC. 7. The Association will hold a Congress, as a rule, every second year.

The arrangements for the Congresses will be discussed in General Meetings and in meetings of the different sections.

Sections will be formed for the different groups of materials as may be considered necessary.

At present there are three sections:

I. Metals.

II. Natural and artificial building stones, cements and mortars.

III. Other materials of practical value.

Any special questions relating to the subjects of the different sections will be considered at sectional meetings.

The members assisting at the sectional debates, under the presidency of a member of the Council, will appoint the committees of the different sections.

The results of the deliberations of the different sections must be communicated at a General Meeting, which will pass resolutions embodying the proposals of the sections.

Reports of Commissions, proposals of the Council and other matters to be laid before the Congress, will be printed in German, French and English, and will be sent (in the language preferred) to all members who have announced their intention of taking part in the Congress, within fourteen days before the meeting of the Congress, if possible.

The decisions of the Congress will be printed in all three languages and sent to all members of the Association.

SEC. 8. The Council of the Association will transact all necessary business connected with the Association.

The Council will consist of the President and the duly elected members.

Every country represented in the Association by at least twenty members has the right to elect one member as member of the Council. For those countries where the number of members

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is under twenty, the Council appoints a Mandatary who takes part in the Council's Meeting with voting powers.

The President will be elected by the Congress, the Council by the members belonging to the different countries.

Till such election has taken place the former members of the Council remain in office.

The names of proposed new members of the Council have to be communicated to the President before each Congress.

The two Vice-Presidents will be elected by the Council from among its own members.

The Council has the power to elect Past Presidents as permanent members of Council.

The Council is entitled to transact business when it has been duly called together according to rule and when the President or one of the Vice-Presidents is present.

Retiring members of the Council are eligible for re-election.

If a member of the Council resigns during his term of office, the President shall immediately direct the election of a successor by the members belonging to the country in question.

In the event of the death or resignation of the President, the Council will appoint one of its members to carry on the presidential duties till the next Congress.

The term of office of the Council lasts from one Congress till the next.

SEC. 9. The business of the Association will be attended to by a salaried General Secretary under the direction of the President.

The members of the Council will attend to the business of the Association in the country which they represent.

SEC. 10. The resolutions of the Congresses on technical questions merely serve to express the opinion of the majority. They are therefore in the form of recommendations and are in no way binding.

SEC. 11. The resolutions of the Congresses can only be carried if at least three-fourths of the recorded votes are in favor of them. Every member of the Association present, as well as every representative of official bodies and technical societies, has one vote.

The rights and duties of a member of the Association are not altered by the fact of his belonging at the same time to a national or other Association, which Association is itself a member of the International Association.

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SEC. 12. The technical problems to be considered by the Association will be decided upon by the Congresses and by the Council, and will be duly referred to commissions or referees appointed by the Council,

SEC. 13. The Council draws up its own regulations according to the By-Laws of the Association and to the needs which may from time to time present themselves.

SEC. 14. In the event of the Association being dissolved, any funds belonging to it will be handed over to the "International Red Cross Association."

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THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Technical Problems, Committees* and Referees.

As constituted in May, 1911.

A. METALS.

Problem 1.—On the basis of existing specifications, to seek methods and means for the introduction of international specifications for testing and inspecting iron and steel of all kinds. (Proposed at the Zurich Congress, 1895; enlarged at the Budapest Congress, 1901.)

Committee:

Chairman.—A. Rieppel, Aeussere Cramer-Klettstrasse 12, Nuremburg, Germany.

American Members.—Carnegie Steel Company; Henry M. Howe; Paul Kreuzpointner; Richard Moldenke; William R. Webster; Walter Wood.

Problems 1a and 1b.—On the basis of unified specific-a tions recognized in the various countries, to attempt the introduction of international unified specifications for iron and steel of all kinds. (Drawn up at the Twentieth and Twenty-first Council's Meeting, 1910.)

Committee 1a, on Steel and Steel Products:

Chairman.—A. Rieppel, Aeussere Cramer-Klettstrasse 12, Nuremburg, Germany.

American Members.—W. A. Bostwick; William R. Webster.

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*The names of only the Chairmen, the Vice-Chairmen, and American Members of International Committees are here given.

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Committee 1b, on Cast Iron and Cast-Iron Products.

Chairman.—W. Brüggemann, Dortmund, Germany.
American Members.—Richard Moldenke; Walter Wood.

Problem 4.—Methods for testing welds and weldability. (Proposed at the Zurich Congress, 1895.)

Problem 24.—On uniform nomenclature of iron and steel. (Resolution of Council, February 3, 1901.)

Committee:

Chairman.—Henry M. Howe, Broad Brook Road, Bedford Hills, N. Y.
Vice-Chairmen.—L. Lévy, Rue de La Rochefoucauld 19, Paris, France; D. Tschernoff, Rue Pessotschnaya 25, St. Petersburg, Russia.
Secretary.—Albert Sauveur, Rotch Building, Harvard University, Cambridge, Mass.
American Members.—American Institute of Mining Engineers, represented by R. Hibbard; American Iron and Steel Institute, represented by C. Kirchhoff; American Society of Mechanical Engineers; William Campbell; Joseph W. Richards; Hugh P. Tiemann.

Problem 25.—To draw up methods of testing cast iron and finished castings. (Proposed at the Budapest Congress, 1901; altered at the Twentieth Council's Meeting in the sense of the Copenhagen Congress resolution.)

Problem 26.—Collection of data which permit the ascertaining of relations between the properties revealed by impact tests on notched bars and the behavior of the pieces in service. Comparison of results obtained with various apparatus. (Resolution of the Copenhagen Congress, 1909.)

Chairman.—G. Charpy, Montluçon, France.

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Problem 27.—Ascertaining the relations between the different methods for determining hardness; fixing the numerical values thus obtained representing the different properties of metals; and determining which method gives the results most in harmony with the wearing properties and useful hardness in practice. (Proposed at the Budapest Congress, 1901.)

Problem 28.—The consideration of the magnetic and electric properties of materials in connection with their mechanical testing. (Proposed at the Budapest Congress, 1901.)

Referee.—Charles W. Burrows, Bureau of Standards, Washington, D. C.

Problem 38.—The principles for specifications of copper and copper alloys are to be studied. (Proposed at the Brussels Congress, 1906; enlarged at the Copenhagen Congress, 1909.)

Committee:

Chairman.—Léon Guillett, 8, Avenue des Ternes, Paris, XVIIe, France.

American Members.—C. E. Skinner; H. E. Diller.

Problem 44.—Relations between the chemical composition, the thermic treatment, and the properties of special steels. (Drawn up at the Twentieth Council's Meeting, 1910.)

Problem 45.—Studying methods for determining the enclosures, their influence upon the mechanical properties of metallurgical products, and for the study of this question on the whole. (Drawn up at the Copenhagen Congress, 1909.)

Problem 46.—Drawing up of unified tests for the resistance of metals to mechanical wear. (Proposed at the Copenhagen Congress, 1909.)

Problem 47.—Methods for ascertaining the resistance of metals to alternating stresses. (Drawn up at the Twentieth Council's Meeting, 1910.)

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Problem 48.—Influence of increased temperature on the ductility and malleability of metals. (Drawn up at the Twentieth Council's Meeting, 1910.)

Problem 49.—Classification of pig iron. To ascertain how far specification on analysis may be substituted for the method of grading by fracture appearance. (Drawn up at the Copenhagen Congress, 1909.)

Referred to Committee 1b.

Problem 53.—Defining the microscopic constituents of iron and steel. (Drawn up at the Twenty-first Council's Meeting, 1910.)

Committee:

Chairman.—Henry M. Howe, Bound Brook Road, Bedford Hills, N. Y.

Secretary.—Albert Sauveur, Rotch Building, Harvard University, Cambridge, Mass.

Problem 54.—To examine all available data showing the relation between the working stress (*a*) on structural members which have failed and (*b*) on those which have not failed, on one hand, and the six properties, elastic limit, yield point, proportionality limit, tensile strength, resistance as notched bars, and endurance, on the other hand: with the purpose of learning which of these six properties is the most closely related to the safe working stress in the several chief classes of structures. (Proposed at the Twenty-first Council's Meeting, 1910.)

B. HYDRAULIC CEMENTS, STONES, AND CONCRETE.

Problem 7.—Investigations on the weathering resistance of building stones; the influence of smoke, especially sulphurous acid, on building stones; the weathering qualities of roofing slates. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—A. Hanisch, Währingstrasse 59, Vienna, IX, Austria.

Vice-Chairman.—P. Larivière, 170, Quai de Jemmapes, Paris, Xe, France.

American Member.—Mansfield Merriman.

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Problem 9.—On rapid methods for determining the strength of hydraulic cements. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—F. Berger, Schottenfeldgasse 37, Vienna, VII, Austria.
American Members.—W. W. Maclay; Charles F. McKenna.

Problem 10.—To digest and evaluate the resolutions of the conferences of 1884-1893 concerning the adhesive qualities of hydraulic cements. (Proposed at the Zurich Congress, 1895.)

Problem 11.—To establish methods for testing puzzolanas, with the object of determining their value for mortars. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—G. Herfeldt, Andernach a. Rh., Germany.
Vice-Chairman.—C. Segré, Ancona, Italy.
American Member.—A. Lundteigen.

Problem 12.—Investigation on the behavior of cements as to time of setting, and on the best method for determining the beginning and the duration of the process of setting, with special reference to ball pressure tests. (Proposed at the Zurich Congress, 1895; enlarged in conformity with the resolution of the Budapest Congress, 1901; completed at the Twentieth Council's Meeting, 1910.)

Problem 30.—Determination of the simplest method for the separation of the finest particles in Portland cement by liquid and air processes. (Proposed at the Budapest Congress, 1901.)

Committee:

Chairman.—M. Gary, Gross-Lichterfelde, W., Germany.
American Member.—Henry S. Spackman Engineering Company.

Problem 31.—On the behavior of cement in sea water. (*a*) Additional information to the reports presented at the Copenhagen Congress, 1909, and information on the effect of sea water on Portland-cement sea structures of more than twenty-five years' standing.

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(*b*) Study of the effect of sea water on specially prepared cements. (Proposed at the Budapest Congress, 1901; completed at the Copenhagen Congress, 1909.)

Referee to Problem (*a*).—E. Leduc, Paris, France.

Committee (*b*):

Chairman.—E. Leduc, Paris, France.
American Member.—Robert W. Lesley.

Problem 32.—On accelerated tests of the constancy of volume of cements. (Decision of the Zurich Congress, 1895.)

Problem 40.—Study of the unification of specifications for gypsum. (Proposed at the Brussels Congress, 1906.)

Problem 41.—Investigations of reinforced concrete. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—F. Schüle, Polytechnikum, Zurich, Switzerland.
Vice-Chairmen.—M. Germelmann, W. Wilhelmstrasse 80, Berlin; A. N. Talbot, University of Illinois, Urbana, Ill.
American Members.—R. L. Humphrey; F. E. Turneaure.

Problem 42.—Uniform tests of hydraulic cements by prisms, and determination of a standard sand. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—F. Schüle, Polytechnikum, Zurich, Switzerland.
American Member.—R. L. Humphrey.

Problem 50.—On the influence of the composition of the mortar and the quality of the building stone on the weathering of masonry. (Proposed at the Copenhagen Congress, 1909.)

Chairman.—A. van der Kloes, Delft, Holland.

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C. MISCELLANEOUS.

Problem 18.—On the methods of testing the protective power of paints used on metallic structures. (Proposed at the Zurich Congress, 1895.)

Referee.—Allerton S. Cushman, Institute of Industrial Research, Washington, D. C.

Problem 34.—Fixing a uniform definition and nomenclature of the bitumens. (Proposed at the Budapest Congress, 1901.)

Referee.—D. Holde, Gross-Lichterfelde, W., Germany.

Problem 35.—Study of the methods of testing caoutchouc. (Proposed at the Budapest Congress, 1901.)

Chairman.—E. Camerman, 31 Square-Guttenberg, Brussels, Belgium.

Problem 39.—Study of the principles of specifications of oil for technical purposes. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—M. Albrecht, Hamburg, Germany.
Vice-Chairman.—E. Camerman, 31 Square-Guttenberg, Brussels, Belgium.
American Member.—A. H. Gill.

Problem 51.—Examination into the desirability of making wood tests on larger pieces containing defects or variations in structural form instead of limiting the tests to small perfect pieces. (Drawn up at the Copenhagen Congress, 1909.)

Referee.—M. Rudeloff, Gross-Lichterfelde, Germany.

Problem 52.—Nomenclature of certain technical qualities connected with internal strains. (Drawn up at the Twentieth Council's Meeting, 1910.)

Chairman.—A. Mesnager, 182 Rue de Rivoli, Paris, I, France.

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SUMMARY OF THE PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING.

ATLANTIC CITY, N. J., JUNE 27–JULY 1, 1911.

THE FOURTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS was held at the Hotel Traymore, Atlantic City, N. J., on June 27–July 1, 1911. The total registered attendance at the meeting, including 92 ladies and 61 guests, was 454.

The following members were present or represented at the meeting:

Abraham, Herbert.
Adams, H. C.
Aertsen, Guilliaem.
Aiken, W. A.
Ajax Metal Company, G. H. Clamer.
Akin, Thomas B.
Allan, Andrew, Jr., William T. Allan.
American Asphaltum and Rubber Company, H. B. Pullar.
American Brass Company, William H. Bassett.
American Bridge Company, C. C. Schneider.
American Foundrymen's Association, Richard Moldenke.
American Locomotive Company, S. V. Hunnings.
American Steel and Wire Company, J. F. Tinsley.
Armstrong, T. P.
Ashby, E. B.
Atwood, J. A.
Aupperle, James A.

Backert, A. O.
Baldwin Locomotive Works, G. H. Woodroffe.
Barrett Manufacturing Company, William S. Babcock.
Bates, P. H.
Bausch and Lomb Optical Company, H. E. Howe.
Baxter, Florus R.
Beale, H. A., Jr.
Beall, Frank F.
Beck, Wesley J.
Belden, A. W.
Bent, H. B.
Berry, H. C.
Bethlehem Steel Company, L. H. Atkinson.
Blair, Will P.
Blanchard, Arthur H.
Bole, William A.
Bonzano, A.
Boston Elevated Railway Company, J. Walter Allen.
Bowman, L. H.
Boynton, C. W.
Boynton, Henry C.
Bridgeport Brass Company, William R. Webster.

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Brown, John G.
Buck, D. M.
Buffalo, Rochester and Pittsburg Railway Company, H. G. Burnham.
Burgess, Charles F.
Burrows, Charles W.
Bush, B. F., Floyd F. Chadwick.

Cambria Steel Company, E. F. Kenney.
Camp, J. M.
Campbell, William.
Capp, J. A.
Carnegie Steel Company, C. F. W. Rys.
Carney, F. D.
Carpenter, A. W.
Carpenter Steel Company, J. H. Parker.
Chamberlain, G. D.
Charls, G. H.
Christie, A. J.
Christie, James.
Church, Sumner R.
Churchill, Charles S.
Cobb, E. B.
Coggeshall, G. W.
Colby, Albert Ladd.
Colby, J. Allen.
Colorado Fuel and Iron Company, Jacob Cambier.
Condit, E. A., Jr.
Cook, Edgar S.
Cooper, James B.
Corse, W. M.
Corson, C. E.
Crocker-Wheeler Company, F. S. Dellenbaugh, Jr.
Crosby, W. W.
Cuntz, William C.
Cushing, W. C.
Cushman, Allerton S.

Davies, George C.
De Pierrefeu, A. D.
Derby, W. A.
Dewar, John.
Dewey, Bradley.
De Wyrall, Cyril.
Dixon Crucible Company, M. McNaughton.
Douty, D. E.
Dudley, P. H.

Electrical Testing Laboratories, F. M. Farmer.
Elliott, George K.
Engineering Record, John M. Goodell.

Farmer, F. M.
Fay, Henry.
Ferguson, Lewis R.
Fireman, Peter.
Fisher, Henry W.
Fleming, William R.
Force, H. J.
Forrest, C. N.
Fort, E. J.
Fowler, George A. (*Railway Age Gazette*).
Froehling and Robertson, Andrew Robertson.
Fuller, William B.
Fulweiler, W. Herbert.

Gardner, Henry A.
General Electric Company, J. A. Capp.
Gibboney, James H.
Glasgow Iron Company, James P. Roe.
Goldbeck, Albert T.
Goodspeed, G. M.
Gormully, A. R.
Greenman, Russell S.
Gregory, E. D.
Griffith, R. E.

Haas, Frank, R. E. Rightmire.
Hall, John H.

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Hammond, George T.
Hancock, E. L.
Harris, J. R.
Hartford Steam Boiler Inspection and Insurance Company, S. B. Adams.
Hartranft Cement Company, W. G., W. G. Hartranft.
Hastings, C. L.
Heckel, G. B.
Heidenreich, E. Lee.
Henry, J. A.
Hering, Rudolph.
Hibbard, Henry D.
Hilles, R. W.
Holst, J. L.
Hopkins, George A.
Howard, James E.
Howe, Henry M.
Hubbard, Prévost.
Hume, A. P.
Humphrey, Richard L.
Hunnings, S. V.
Hunt Company, Robert W., Robert W. Hunt.

Ickes, E. T.
Illinois Central Railroad Company, J. S. Sheafe.
Illinois Steel Company, P. E. Carhart.
Ingalls, F. P.
Ingberg, S.
Iron Age, The, W. W. Macon.
Iron Trade Review, The, A. O. Backert.

Jarecki, Alexander.
Jeffers, John M.
Jennings, R. E., 2d.
Job, Robert.
Johnson, Charles W.
Jones and Laughlin Steel Company, Jesse J. Shuman.
Jones, C. R.
Jones, Jesse L.
Jones, Morgan T.

Kaufman, Gustave.
Kelsey, V. V.
Kenney, E. F.
Kershaw, William H.
Kinkead, J. A.
Kinney, William M.
Kirchoff, C.
Kirschbraun, L.
Koch, George B.
Kohr, Donald A.

Langenbach, E. O., John N. Remsen.
Lanza, Gaetano.
Larned, E. S.
Lawson, T. R.
Lazell, E. W.
Leech, J. O.
Lesley, Robert W.
Lewis, A. W.
Lindemuth, L. B.
Linder, Oscar.
Little, Incorporated, Arthur D., Carl F. Woods.
Locke Insulator Manufacturing Company, The, Walter T. Goddard.
Lovell, Alfred.
Lowe Brothers Company, The, Donald A. Kohr.
Lucas and Company, John, Leo P. Nemzek.
Lukens, Alan N.
Lum, D. W.
Lynch, T. D.

Macgregor, James S.
Macnichol, Charles.
MacPherran, R. S.
Mahon, R. W.
Mannhardt, Hans.
Marburg, Edgar.
Marston, A.

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Masury and Son, John W., William S. Baldwin.
Mathews, John A.
McCleary, E. T.
McDonnell, M. E.
McFarland, G. S.
McGrady, J. W.
McKibben, Frank P. Leon D. Conkling.
McLeod, John.
McNaugher, D. W.
Mead, Charles A.
Meade, Richard K.
Meriwether, Coleman.
Merriman, Mansfield.
Metal Industry, The, L. J. Krom.
Midvale Steel Company, Radclyffe Furness.
Miller, Rudolph P.
Moissieff, Leon S.
Moldenke, Richard.
Morris, D. A.
Myers, J. E.

National Tube Company, Frank N. Speller.
Neal, C. S.
New Jersey Zinc Company, George C. Stone.
Norris, George L.

Olsen, Thorsten Y.
Olsen, Tinius, Thorsten Y. Olsen.
Orton, Edward, Jr.
Outerbridge, Alexander E., Jr.

Page, L. W.
Page, W. Nelson, Raleigh C. Taylor.
Pease, Burton H.
Penniman and Browne, W. B. D. Penniman.
Pennsylvania Crusher Company, G. W. Borton.
Pennsylvania Steel Company, H. B. Bent.
Perley, George E.
Perry, R. S.
Pickard, Glenn H.
Polk, Anderson.
Porter, J. Madison.
Prentiss, George N.
Price, Charles P.
Provost, A. J., Jr.

Quimby, Henry H.

Railway and Engineering Review, The, Willard A. Smith.
Railway Steel Spring Company, Alan N. Lukens.
Ramage, J. C.
Reading Iron Company, George Schuhman.
Reinke, W. B.
Remington Arms and Ammunition Company, Nathan A. Chase.
Riehlé, Frederick A., William J. Tretch.
Rights, Lewis D.
Rinald, C. D.
Robinson, F. W., Roy W. Lindsay.
Rodgers, S. M.
Roebling's Sons Company, John A., Henry C. Boynton.
Rogers, Allen.
Rossi, James C.
Royal, Joseph.
Rys, C. F. W.

Sabin, A. H.
Sargent, George W.
Sauveur, Albert.
Schall, Frederick E.
Schmitt, F. E. (*Engineering News*).
Schneider, C. C.
Scott, Arthur P.
Scott, R. G., Jr.

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Sellers and Company, Incorporated, William, Alexander E. Outerbridge, Jr.
Sharples, Philip P.
Sheafe, J. S.
Sherwin-Williams Company, The, Edward C. Holton.
Shore, Albert F.
Shuman, Jesse J.
Skinner, C. E.
Smart, L. A.
Smith, Earl B.
Smith, H. E.
Snow, J. P.
Spackman Engineering Company, H. S., Henry S. Spackman.
Spencer, Herbert.
Sperry, W. L.
Spengler, J. H.
Stafford, C. Edward.
Stafford, Samuel G.
Standard Underground Cable Company, Henry W. Fisher.
Standard Steel Works Company, A. A. Stevenson.
Starr, John J.
Stevenson, A. A.
Stone, George C.
Stoughton, Bradley.
Studebaker Library, The, J. A. White.
Swensson, Emil.

Talbot, A. N.
Taylor, Knox.
Taylor, W. Purves.
Tefft, G. H.
Testing Laboratory, City of St. Louis, Mont Schuyler.
Thomas, George, 3d.
Thomas, H. C.
Thompson, G. W.
Thompson, Hugh L.
Thompson, Sanford E.
Thorpe, J. B.
Tiemann, Hugh P.
Tretch, William J.
Tilt, Edwin B.
Toch, Maximilian.
Trautwine, John C., Jr.
Turneaure, F. E.

Unger, J. S.
United Gas Improvement Company, W. Herbert Fulweiler.

Van Gundy, C. P.
Voorhees, S. S.

Waldo, Leonard.
Walker, Percy H.
Walker, William H.
Wallace, John T.
Webster, George H.
Webster, William R.
Western Electric Company, Oscar Linder.
Westinghouse Air Brake Company, H. C. Loudenbeck.
Westinghouse, Church, Kerr and Company, C. M. Chapman.
Westinghouse Electric and Manufacturing Company, C. E. Skinner.
West Virginia University Library, C. R. Jones.
Wetherill, C. T.
Wetherill, Samuel.
Weymouth, F. A.
White, Alfred H.
White, G. A.
White, G. D.
Whittemore, H. L.
Wickhorst, M. H.
Wig, Rudolph J.
Wilhelm Company, The A., E. C. Street, Jr.
Wilson, Percy H.
Winchester Repeating Arms Company, Rupert L. Penney.
Wittman, N. B.
Wood and Company, R. D., Walter Wood.
Wood, Walter.
Woodroffe, G. H.
Worcester, J. R.

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Worcester Polytechnic Institute, E. L. Hancock.
Wyman and Gordon Company, The, G. S. McFarland.
Young, J. Bertram.
Zehnder, C. H.
Zimmerschied, K. W.

Total number, 329; attendance, not including companies, etc., whose representatives also hold membership in their own name, 301.

FIRST SESSION.—TUESDAY, JUNE 27, 3 P. M.

President Henry M. Howe in the chair.

The minutes of the Thirteenth Annual Meeting were approved as printed.

The annual report of the Executive Committee was adopted as printed.

In the absence of Mr. Walter Wood, Chairman of Committee A-3 on Standard Specifications for Cast Iron and Finished Castings, the report of that Committee was presented by Secretary Marburg. Mr. Marburg stated that he had been authorized by Mr. Wood to state that the Committee desired no action taken at this time on the proposed revised Standard Specifications for Locomotive Cylinders, and that the Committee recommended that these specifications be printed in the Proceedings with a view of their adoption in their present or modified form at the next annual meeting of the Society.

On motion, this recommendation of the Chairman of Committee A-3 was approved.

Mr. J. A. Capp, Chairman of Committee B-1 on Standard Specifications for Hard-Drawn Copper Wire, presented the report of that Committee including the proposed amendments to the Standard Specifications for Hard-Drawn Copper Wire.

On motion, these amendments were referred to letter ballot by the prescribed two-thirds vote of those voting.

Mr. Rudolph Hering, Chairman of Committee C-4 on Standard Specifications and Tests for Clay and Cement Sewer Pipes, presented the report of that Committee.

The tellers, Mr. Richard L. Humphrey and Mr. J. A. Capp, appointed by the Chair to canvass the vote on the election of members of the Executive Committee, reported that 131 ballots had been

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cast, and in accordance with their report the Chair declared the election of Mr. W. A. Bostwick, Mr. Robert W. Hunt, Mr. Richard Moldenke and Mr. William R. Webster to membership on the Executive Committee.

The meeting then adjourned till 8 P. M.

SECOND SESSION.—TUESDAY, JUNE 27, 8 P. M.

President Henry M. Howe in the chair.

The Chairman invited Mr. Robert W. Lesley, Vice-President of the Society, to the chair during the presentation of the Annual Presidential Address under the title of: "The American Society for Testing Materials."

The following papers were then read and discussed:

"The Manufacture of Pure Irons in Open-Hearth Furnaces." Allerton S. Cushman.

"Measured Strains on Engineering Structures." James E. Howard.

"A Study of the Heat Treatment of Some Low-Carbon Nickel Steels." Henry Fay and John M. Bierer.

"Flue-Sheet Cinder Formation in Locomotives." Robert Job.

The meeting then adjourned till the following morning.

THIRD SESSION.—WEDNESDAY, JUNE 28, 10 A. M.

On Steel.

President Henry M. Howe in the chair.

In the absence of Mr. William R. Webster, Chairman of Committee A-1 on Standard Specifications for Steel, the report of that Committee was presented by Mr. A. A. Stevenson, Vice-Chairman. Mr. Stevenson called attention to a typographical error in the designation of the upper limit of the carbon content in the proposed Standard Specifications for Forged and Rolled, Forged, or Rolled Solid Steel Wheels for Engine Truck, Tender and Passenger, Subway and Elevated Railway Service, which should be

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0.85 instead of 0.80. Mr. Stevenson moved that the four proposed specifications appended to the report of Committee A-1 for:

"Forged and Rolled, Forged, or Rolled Solid Steel Wheels for Engine Truck, Tender and Passenger, Subway and Elevated Railway Service;"

"Forged and Rolled, Forged, or Rolled Solid Steel Wheels for Freight Car Service;"

"Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts;"

"Steel Reinforcement Bars;"

be referred to letter ballot of the Society.

Mr. Charles S. Churchill moved that the proposed Specifications for Wheels for Freight Car Service and Wheels for Passenger and Other Service be referred back to Committee A-1 for further consideration. This motion was carried.

On motion, the proposed Standard Specifications for Heat-Treated Carbon Steel Axles, Shafts, and Similar Parts, were referred to letter ballot of the Society.

Mr. Albert Ladd Colby moved that the paragraph in the proposed Standard Specifications for Steel Reinforcement Bars relating to check analyses be changed to the following form in order to make this clause consistent with those in other standard specifications for steel: "A check analysis may be made by the purchaser or his representative if desired, in which case an excess of 25 per cent. above the required limits will be allowed."

On motion, the proposed Standard Specifications for Steel Reinforcement Bars as thus amended were referred to letter ballot of the Society.

Mr. Albert Ladd Colby called attention to the desirability of substituting the word "Steels" for "Steel" in the designation of the titles of Sub-Committees VIII and XI in the report of Committee A-1. The Secretary was instructed to make that change.

The President then invited Mr. Mansfield Merriman, Past President of the Society, to the chair.

The report of Committee A-4 on Heat Treatment of Iron and Steel, was presented by Mr. Henry M. Howe, Chairman. Mr. Robert W. Hunt moved that this report be printed both in the Proceedings and the Year Book for the information of the Society. Mr. Howe offered an amendment to this motion to the effect that the proposed Standard Specifications for Annealing

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Miscellaneous Rolled and Forged Carbon-Steel Objects be referred to letter ballot of the Society as "Recommended Practice." This amendment was carried, as well as the original motion thus amended.

The following papers were read by title:

Life History of Network and Ferrite Grains in Carbon Steel." Henry M. Howe.

"The Heat Treatment of a Steel containing 3.15 per cent. Nickel and 0.27 per cent. Carbon." William Campbell and H. B. Allen.

Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, presented the report of that Committee embodying proposed Standard Specifications for:

"Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars."

"Spelter."

"Manganese Bronze Ingots."

On the recommendation of the Committee, as voiced by Mr. Campbell, these three proposed specifications were referred to letter ballot of the Society.

The following papers were then read and discussed:

"A Note upon the Heat Treatment of an Acid and a Basic Open-Hearth Steel of Similar Composition." Henry Fay.

"Studies on Steel Tires." Robert Job and Milton L. Hersey.

A paper on "Ductility in Rail Steel," by Mr. P. H. Dudley, was read by title.

The meeting then adjourned till 8 P. M.

FOURTH SESSION.—WEDNESDAY, JUNE 28, 8 P. M.

On Preservative Coatings.

President Henry M. Howe in the chair.

On behalf of the Executive Committee the Secretary introduced the following motions:

First: That in view of the Sixth Congress of the International Association for Testing Materials, which will be held in this country in September, 1912, the next annual meeting be held in June, 1912,

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and that it be limited to the annual reports of the standing technical committees and administrative business.

Second: That the Executive Committee be authorized to effect a financial arrangement with the Council of the International Association by which every Member of the American Society will receive, without extra charge, a copy of the English edition of the Proceedings of the Sixth Congress, and that every Junior Member of the American Society will receive a copy of these Proceedings on the extra payment of $2.50.

The Secretary explained that the American members of the International Association would by this arrangement receive also advance copies of the Congress Proceedings to which non-members of that Association would not be entitled.

These motions were carried by unanimous vote with the understanding that they will become effective only if confirmed by letter ballot of the Society at large.

On the invitation of the President, Mr. Allerton S. Cushman then assumed the chair.

Mr. S. S. Voorhees, Chairman of Committee D-1 on Preservative Coatings for Structural Materials, presented the annual report of that Committee.

Mr. Cushman then yielded the chair to Mr. Edgar Marburg during his presentation as Chairman of Committee A-5 on the Corrosion of Iron and Steel, of the annual report of that Committee.

The following papers were then read and discussed:

"Further Results of the Westinghouse, Church, Kerr and Company Paint Tests." C. M. Chapman.

"The Value of the Sulphuric Acid Corrosion Test." C. M. Chapman.

"The Marked Influence of Copper in Iron and Steel on the Acid Corrosion Test." William H. Walker.

A paper entitled "The Practical Testing of Drying and Semi-Drying Paint Oils," by Mr. Henry A. Gardner, was read by title.

Mr. Alexander E. Outerbridge, Jr., presented a paper on "A Novel Method of Detecting Mineral Oil and Resin Oil in Other Oils."

The meeting then adjourned till the following morning.

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FIFTH SESSION.—THURSDAY, JUNE 29, 10 A. M.

On Cement and Concrete.

Vice-President Robert W. Lesley in the chair.

A paper entitled "Practical Tests of Sand and Gravel Proposed for Use in Concrete," was read by the author, Mr. Russell S. Greenman.

A paper on "Some Experiments on the Incrustation and Absorption of Concrete" was, in the absence of the author, Mr. A. O. Anderson, read by Mr. A. Marston.

The following papers were, in the absence of their authors, read by title:

"The Determination of Stresses in a Reinforced Concrete Member Subject to Axial Load and Flexure." S. Ingberg.

"The Properties of Magnesium Cement, Mortars and Concretes." C. Derleth, Jr., and A. C. Alvarez.

The following papers were then read and discussed:

"The Expansion and Contraction of Concrete while Hardening." Albert T. Goldbeck.

"Destruction of Cement Mortars and Concrete through Expansion and Contraction." Alfred H. White.

"The Effect of High-Pressure Steam on the Crushing Strength of Concrete." Rudolph J. Wig.

The report of Committee C-3 on Standard Specifications for Paving and Building Brick, was presented by Mr. D. E. Douty, Chairman.

A paper by Messrs. Edward Orton, Jr., and M. W. Blair on "A Study of the Rattler Test for Paving Brick," was read and discussed.

The meeting then adjourned till 3 P. M.

SIXTH SESSION.—THURSDAY, JUNE 29, 3 P. M.

On Steel.

Mr. Robert W. Hunt in the chair.

The report of Committee A-7 on the Tempering and Testing of Steel Springs and Standard Specifications for Spring Steel,

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was read by Secretary Marburg in the absence of the chairman of the Committee, Mr. Henry Souther.

The following papers on Hardness Tests were then read, and discussed jointly:

"Hardness Tests." Bradley Stoughton and J. S. Macgregor.

"A Comparison of Five Methods of Hardness Measurement." R. P. Devries.

"Hardness in its Relation to Other Physical Properties." R. P. Devries.

"The Property of Hardness in Metals and Materials." Albert F. Shore.

Mr. G. Lanza, Chairman of Committee E-1 on Standard Methods of Testing, presented the report of that Committee.

On motion, the recommendation of the Committee that the proposed Standard Methods for Transverse Tests be referred to letter ballot of the Society for adoption was approved by the prescribed two-thirds vote of those voting.

The meeting then adjourned till the following morning.

SEVENTH SESSION.—FRIDAY, JUNE 30, 10 A. M.

On Bitumens.

President Henry M. Howe in the chair.

The report of Committee D-4 on Standard Tests for Road Materials, was read by Mr. Prévost Hubbard, Secretary of the Committee. The recommendation of the Committee that the following methods of tests be referred to letter ballot of the Society as "Provisional Methods" was on motion approved:

"Provisional Method for the Determination of Soluble Bitumen."

"Provisional Method for the Determination of the Penetration of Bitumen."

"Provisional Method for the Determination of the Loss on Heating of Oil and Asphaltic Compounds."

"Provisional Method of Sizing and Separating the Aggregate in Asphalt Paving Mixtures."

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The following papers were then read and discussed:

"A New Consistometer for Use in Testing Bituminous Road Materials." W. W. Crosby.

"Improved Instruments for the Physical Testing of Bituminous Materials." Herbert Abraham.

"Apparatus for Determining the Drop Point and Softening Point of Compounds." Henry W. Fisher.

A paper on "Organic Residues from Soluble Bitumen Determinations," by Messrs. Prévost Hubbard and C. S. Reeve, was read by title.

A paper on "The Behavior of Zinc under Compression" was read by the author, Mr. John C. Trautwine, Jr.

The following papers were then read by title:

"Some Tests on the Rate of Corrosion of Metals Exposed in a Gaseous Atmosphere." A. W. Carpenter.

"Some Causes of Failures in Metals." Henry Fay.

"Asphalt Cement for Use in Sheet Asphalt Pavement: Physical and Chemical Tests to Determine Quality." J. W. Howard.

The following amendment of the by-laws, proposed in the annual report of the Executive Committee, was on motion approved and referred to letter ballot of the Society:

ARTICLE V.

Strike out Sections 1 and 2, viz:

SECTION 1. The fiscal year shall commence in 1910 on the first of August, and the dues from August 1, 1910, to December 31, 1910, shall be $5.00 for Members and $2.50 for Junior Members.

SEC. 2. The fiscal year after December 31, 1910, shall begin on the first of January, and the annual dues from and after January 1, 1911, shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

Substitute the following new section:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

Change the designation of existing Sections 3, 4, 5, 6 and 7, to Sections 2, 3, 4, 5 and 6, respectively.

The meeting then adjourned till 3 P. M.

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EIGHTH SESSION.—FRIDAY, JUNE 30, 3 P. M.

On Testing Apparatus and Methods.

President Henry M. Howe in the chair.

The report of Committee A-6 on the Magnetic Testing of Iron and Steel, was presented by the Chairman, Mr. Charles W. Burrows.

On motion, the recommendation of the Committee that the proposed Standard Magnetic Tests of Iron and Steel be referred to letter ballot of the Society for adoption, was approved by the prescribed two-thirds vote of those voting.

The following papers were then read and discussed:

"A New Method of Testing the Endurance of Case-Hardened Gears and Pinions." J. S. Macgregor and Bradley Stoughton.

"New Types of Impact Testing Machines for Determining Fragility of Metals." T. Y. Olsen.

"A New Type of Autographic Transverse Testing Machine for Research Testing or Regular Foundry Practice." T. Y. Olsen.

"Standard Methods for Testing Sewer Pipe and Drain Tile." A. Marston.

The meeting then adjourned till the following morning.

NINTH SESSION.—SATURDAY, JULY 1, 10 A. M.

Miscellaneous.

Mr. A. N. Talbot in the chair.

A paper on "The Fritz Engineering Laboratory of Lehigh University" was, in the absence of the author, Mr. Frank P. McKibben, read by Mr. L. D. Conkling.

A paper on "A Study of the Elastic Properties of a Series of Iron-Carbon Alloys," by Messrs. C. R. Jones and C. W. Waggoner, was read by Mr. Jones.

In the absence of the authors the following papers were then read by title:

"Specifications and Grading Rules for Douglas Fir Timber: an Analysis of Forest Service Tests on Structural Timbers." McGarvey Cline.

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"The Brinell Ball Test Applied to Wood." W. K. Hatt.

"Notes on Anti-Friction Alloys." William Campbell.

The following paper was read and discussed:

"Some Further Experiments upon the Absorption, Porosity, and Specific Gravity of Building Brick." D. E. Douty and L. L. Beebe.

On behalf of Mr. J. A. Holmes, Chairman of Committee D-5 on Standard Specifications for Coal, the report of that Committee was read by Mr. A. W. Belden. This was followed by the presentation of a paper on "Fuel Investigations, Bureau of Mines," by Mr. A. W. Belden.

By permission of the Chair, Mr. G. L. Fowler introduced a discussion of a paper read at the preceding meeting on "A New Method of Testing the Endurance of Case-Hardened Gears and Pinions," by Messrs. J. S. Macgregor and Bradley Stoughton.

In the absence of the Chairman, Mr. C. E. Skinner, the report of a committee appointed by the Executive Committee to report on the standardization of form of the standard specifications of the Society was presented by Mr. C. W. Burrows, who introduced the following motion:

"That the Executive Committee be requested to appoint a Committee whose duty it shall be to formulate rules governing the form but not the substance of specifications."

The Secretary announced that the Executive Committee had decided to publish an index of Volumes I to X, inclusive, of the Proceedings.

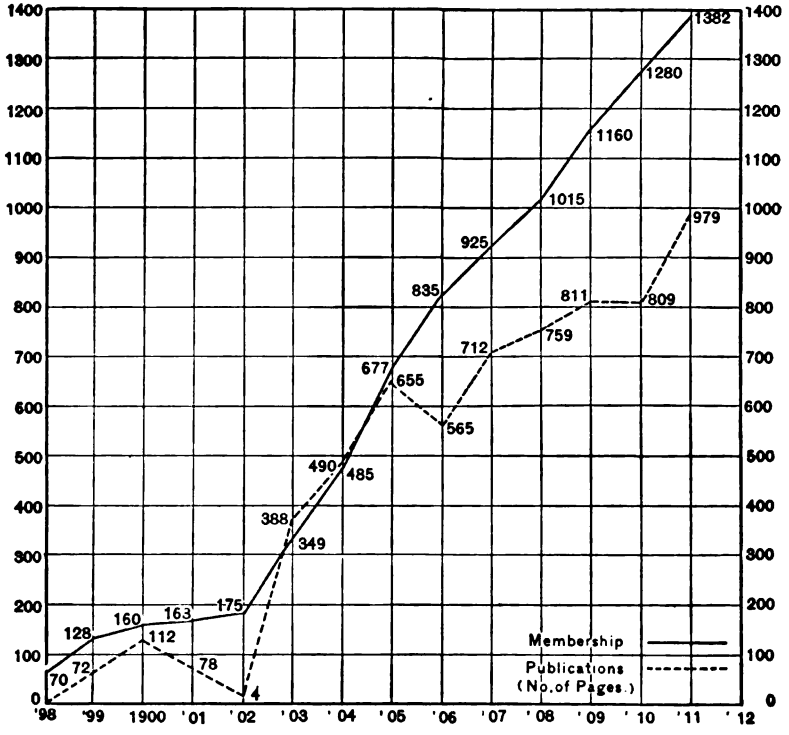
The Chairman then declared the meeting adjourned *sine die.*

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ANNUAL REPORT OF THE EXECUTIVE COMMITTEE.

Since the Thirteenth Annual Meeting of the Society, the Executive Committee has held four regular meeting. An abstract of the minutes of these meetings is appended to this report.

Membership.—The membership at the last annual meeting was 1,280. Since then 274 applications for membership have been approved, as compared with 154 applications during the



preceding year, that is, a net gain of 120. The Society has suffered the loss of two members in the death of Nelson A. Hallett, which occurred on August 9, 1910, and that of Mace Moulton, whose death occurred on April 27, 1909, but was not brought to the notice of the Secretary until after the last annual meeting. The

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number of resignations for the year is 95, and 75 members have been dropped for arrears in dues. The number of resignations is nearly four times as large as the number for the preceding year, which is directly attributable to the increase of dues. While the full influence of this measure will not be known until the end of the current year, its effect thus far has been much less marked than might reasonably have been anticipated. The total loss from all causes is 172, making a net gain of 102, and making the total membership at present 1,382. This estimate includes 76 members in arrears for dues prior to January 1, 1911, the Executive Committee having decided to extend the time for delinquents till July 1, 1911. The number of members in arrears for dues included in the last annual report was about the same as this year, so that the reported net gain of 102 in the membership for the year is substantially correct. It is highly gratifying to observe that the normal rate of growth of the Society for the last five years has been maintained during the past year, despite the fact that the membership dues have been doubled.

Publications.—The publication of a year-book, rendered possible by the increase of dues, was begun with the Year-Book for 1910, issued last September, containing 308 pages. A cloth-bound copy of this volume, containing all the standard specifications adopted by the Society, the list of members, the personnel of the technical committees, and a variety of other matter, was sent to every member of the Society. A large number of copies have also been disposed of by sale.

Volume X, containing 671 pages devoted to the proceedings of the last annual meeting, was also distributed among the members for the first time in cloth binding, without extra charge for binding. Eight official circulars of information have also been issued during the year. In addition to the foregoing regular publications aggregating nearly a thousand pages, the Society published a special memorial volume of 269 pages, commemorative of the life and life-work of its late President, Dr. Charles B. Dudley.

There is perhaps no better criterion of the estimate in which the work of the Society is held in outer circles than that reflected by the proceeds from the sale of its publications. The total receipts from this source for the year 1908-1909 was $875.44, for the year 1909-1910, $1,375.85, and for the past year $2,539.50, exclusive of

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the proceeds from the sale of the Dudley memorial volume. Since the stock of certain volumes is being rapidly depleted, the Executive Committee has decided to discontinue the separate sale of any volume as soon as the number of copies of that volume has been reduced to one hundred. Such volumes will then be obtainable only by the purchase of complete sets of the back publications.

Technical Committees.—Appointments have recently been completed on Committee A-2 on "Standard Specifications for Wrought Iron," under the temporary chairmanship of Mr. J. Allen Colby, and on Committee C-6 on "Standard Tests and Specifications for Drain Tile," under the temporary chairmanship of Mr. A. Marsten. The Executive Committee has also authorized the creation of Committee E-3 on "The Definition of the Term 'Modulus of Elasticity' in its Application to Materials, including Non-Ferrous Metallic Metals and their Combinations," under the temporary chairmanship of Mr. Leonard Waldo.

The previous action, by which the creation of Committee A-11 on "Metallurgical Research in Steel" and Committee A-12 on "Tests of Steel Structural Members" had been authorized by the Executive Committee, has been rescinded.

Finances.—For the first time in its history the Society is now on a thoroughly sound and independent financial footing. Instead of a deficit of $2,200 which existed a year ago, there is a cash balance in the treasury of $6,792.05 with no outstanding liabilities. This improvement is due partly to the increase of membership and to the increased sale of publications, but in the main to the increase in membership dues. The favorable financial condition of the Society would have made it possible to publish papers and committee reports in advance of this meeting in much larger measure than has been done had it been found feasible to secure the manuscripts in time. The experience in this respect has been, however, very disappointing, only two or three manuscripts having been received earlier than four weeks in advance of the annual meeting. The only remedy would appear to be the strict adherence to a limiting date for the receipt of papers, sufficiently far in advance of the annual meeting. This, however, would doubtless frequently operate to exclude valuable material and would be likely to prove at times embarrassing to the technical committees.

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ANNUAL REPORT OF THE TREASURER.

From June 15, 1910, to June 15, 1911.

RECEIPTS.

Membership dues		$17,308 10
Sales of publications		2,539 50
Orders for binding		287 50
Authors' reprints		152 62
Sales of right to reprint specifications for one year		750 00
Sales of Dudley Memorial Volume		488 50
Interest on deposits		25 52
Excess remittances		64 60
Miscellaneous receipts		12 25
International Association dues and sales of publications		1,110 98
International Association, subvention of United States Steel Corporation		250 00
Total receipts		$22,989 57
Cash balance, June 15, 1910		681 30
		$23,670 87

DISBURSEMENTS.

Printing, engraving, binding, etc		$8,326 12
Secretary's salary, May 31, 1910, to May 31, 1911		1,708 33
Clerical services		1,998 57
Accountant's audits		80 00
Expenses, Secretary's office:		
Postage and expressage	$373 96	
Other expenses	317 63	691 59
Addressograph equipment		124 34
Rent and expenses, storage room		203 60
Repayment of temporary loan		1,000 00
Interest on loan		45 83
Stenographer, Thirteenth Annual Meeting		150 00
Expenses, Thirteenth Annual Meeting		69 97
Expenses, Technical Committees		120 34
Cost of Dudley Memorial Volume		920 60
Excess remittances refunded		64 60
Miscellaneous disbursements		25 50
Expenses, 1912 Congress I. A. T. M.		28 95
Remitted to International Association:		
Subvention U. S. Steel Corporation	$250 00	
Dues and sales of publications	942 42	1,192 42

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For account of International Association, postage, printing, etc	$128 06	
Total disbursements	$16,878 82	
Cash balance, June 15, 1911	6,792 05	
		$23,670 87

COMMITTEE FUNDS.

RECEIPTS.

Committee D-1	$50 00	
Interest on deposit	2 17	
Total receipts	$52 17	
Cash balance, June 15, 1910	215 00	
		$267 17

DISBURSEMENTS.

Committee D-1	$24 75	
Cash balance, June 15, 1911	242 42	
		267 17

The item of $8,326.12 reported as the cost of publications includes the balance of $2,000 mentioned in the last annual report as due but unpaid at that time.

Proposed Amendment of the By-Laws.—By the amendment of the by-laws adopted last year the beginning of the fiscal year was changed from July 1 to January 1. To effect this change it became necessary to make the following temporary provisions in Sections 1 and 2 of Article V of the by-laws. These sections having now served their purpose, the following amendments are proposed:

ARTICLE V.

Strike out Sections 1 and 2, viz:

SECTION 1. The fiscal year shall commence in 1910 on the first of August, and the dues from August 1, 1910, to December 31, 1910, shall be $5.00 for Members and $2.50 for Junior Members.

SEC. 2. The fiscal year after December 31, 1910, shall begin on the first of January, and the annual dues from and after January 1, 1911, shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

Substitute the following new section:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

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Change the designation of existing Sections 3, 4, 5, 6 and 7 to Sections 2, 3, 4, 5 and 6, respectively.

International Association for Testing Materials.—The Sixth Congress of the International Association for Testing Materials will be held in this country during the first half of September, 1912, at dates not yet definitely determined. It is hoped that the dates will be so arranged that sectional meetings may be held in common with sectional meetings of the Congress of Applied Chemistry, which will be convened in Washington, D. C., on September 4, and will hold meetings in New York from September 6-13, 1912.

By action of the Executive Committee the nucleus of the general Organizing Committee of the Congress will consist of the members of the Executive Committee and the officers of the standing technical committees. A meeting of this body has been held, at which it was decided that the Executive Committee of the Organizing Committee shall be constituted as follows:

The President of the American Society for Testing Materials.

The Vice-President of the American Society for Testing Materials.

The Secretary of the American Society for Testing Materials.

The Chairmen of the Committees of the General Committee on Organization.

At this meeting it was further decided to create the following committees:

(*a*) Finance Committee.
(*b*) Committee on Papers.
(*c*) Committee on Transportation.
(*d*) Committee on Excursions.
(*e*) Committee on Information.
(*f*) Reception Committee.
(*g*) Local Committee.
(*h*) Ladies Committee.

The Executive Committee of the American Society was authorized to appoint five members on each of these committees with the understanding that each committee will elect its own chairman and will be empowered to enlarge its own membership

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subject to the approval of the Executive Committee of the Organizing Committee. The appointments on the above committees have been made and the preliminary work for the Congress will now be vigorously prosecuted.

The Executive Committee desires to make an earnest appeal to the members of the Society to render every assistance in their power towards making the Sixth Congress a highly successful and memorable occasion.

The American membership in the International Association is now 473 as against 415 a year ago, and outnumbers for the first time every other national membership in that organization. In view of the approaching Congress the American membership should, however, be greatly increased during the coming year. Every member of the American Society is by virtue of such membership eligible for admission to the International Association. Application blanks for membership may be obtained from the Secretary of the American Society. The annual dues in the International Association are $2.00. The fiscal year begins on January 1 and there is no initiation fee. In addition to the regular Proceedings of the International Association, members of the Association are entitled to the Congress Proceedings in German, French, or English without extra charge. The Copenhagen Congress yielded over 1,000 pages of printed matter and it is confidently anticipated that this record will be equaled or surpassed at the approaching Congress. The Committee on Papers will make every effort towards insuring a creditable participation on the part of the American members in the proceedings of the Congress.

Respectfully submitted on behalf of the Executive Committee,

HENRY M. HOWE,
President.

EDGAR MARBURG,
Secretary-Treasurer.

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APPENDIX.

ABSTRACT OF THE MINUTES OF THE EXECUTIVE COMMITTEE.

REGULAR MEETING, June 29, 1910.—Hotel Traymore, Atlantic City, N. J. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. W. A. Bostwick and Mr. James Christie, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported the receipt of 24 applications for membership, duly approved, the resignation of 9 members, and the loss of 1 member by death, Mr. D. H. Pierce, July 1, 1909, making the total membership on June 15, 1910, 1,280.

The Secretary reported that the letter ballot held last year on the proposed standard tests for bituminous compounds, and which resulted favorably, should not have been taken, inasmuch as it was not the intention of the Committee on Standard Tests for Road Materials to have this matter submitted to letter ballot. The Secretary was accordingly instructed not to have this matter printed or announced among the standard specifications of the Society.

Mr. J. M. Goodell was appointed as the official representative of the Society at the International Road Congress at Brussels.

It was decided that the notice to the membership at large relative to the proposed regulations governing the chairmanships of technical committees, to be accompanied by arguments pro and con, in connection with the letter ballot authorized by vote at the first session of the annual meeting, be deferred until fall, so that in the meantime members of the Society may be given full opportunity to advance arguments pro and con by letter. The Secretary was instructed to present such correspondence at the next quarterly meeting of the Executive Committee, together with a proposed form of announcement with arguments pro and con.

The Secretary presented a design for a Society emblem prepared by Mr. G. E. Doke, a member of the Society, and he was instructed to obtain other designs from leading firms with a view of submitting the same to the Executive Committee at its next meeting.

REGULAR MEETING, October 3, 1910.—Engineers' Club, Philadelphia, Pa. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. James Christie, Member of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported that 99 new members had qualified for membership, that 36 members had resigned, and that 73 members had been dropped, making the total membership on October 1, 1910, 1,270.

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The Treasurer presented a report from John Heins & Co., Public Accountants and Auditors, dated July 16, 1910, to the effect that they had made "an audit and examination of the books and accounts of the Society for the six months ending June 30, 1910, and report them to be correctly and carefully kept."

The Secretary presented the following report of Committees of Tellers:

1. ON THE AMENDMENTS OF THE BY-LAWS.

Amendment to	Affirmative.	Negative.	No vote.
Article I	228	15	..
" II	242	1	..
" V	218	23	2

Total ballots counted, 243. Ballots rejected as irregular, 7. Dated July 26, 1910, and signed by Mr. Henry H. Quimby and Mr. W. Purves Taylor, Tellers.

2. LETTER BALLOT ON SPECIFICATIONS.

Specifications for	For.	Against.	Not voting.
Staybolt Iron	116	5	8
Yellow-Pine Bridge and Trestle Timbers.	105	4	20
Methods of Testing	125	3	1

Total ballots counted, 129; rejected, none. Dated, September 2, 1910, and signed by Mr. Henry H. Quimby and Mr. W. Purves Taylor, Tellers.

The Secretary presented a letter, dated July 19, 1910, from Mr. R. K. Johnson, written on behalf of Mr. H. V. Wille, Chairman of Committee A-10 on Standard Specifications for Staybolt Iron, requesting the discharge of that Committee. It was the sense of the meeting that such action would be undesirable in view of the fact that the Standard Specifications for Staybolt Iron have only recently been adopted, and the desirability of referring criticisms of the same to a properly constituted committee. The request was accordingly laid on the table.

The question of appointments on the newly authorized committees, A-11 on Metallurgical Research in Steel and A-12 on Tests of Steel Structural Members, was considered. It was decided to rescind the previous action in this matter and not to proceed with the organization of these committees.

The Secretary presented a letter under date of July 5, 1910, from Mr. Edwin B. Tilt, recommending the creation of a Committee on Standard Specifications for Rubber Products. After due consideration it was decided to lay this recommendation on the table.

The Secretary was authorized to advise the International Association of the nomination of Mr. Charles W. Burrows as the American representative on International Committee 28 on "The Consideration of the

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Magnetic and Electric Properties of Materials in Connection with their Mechanical Testing."

The request of the National Association of Cement Users to be permitted to reprint the Standard Specifications for Cement with the understanding that due credit would be given to the Society was approved.

The Secretary was authorized to print the addresses at the Dudley Memorial Session of the recent annual meeting in the Proceedings of the Society as well as in the Dudley Memorial Volume.

The Secretary reported that certain circular matter had been sent to a selected list of 543 libraries and 147 deans of technical schools with a view of placing the remaining complete files of the Proceedings, in so far as possible, in libraries.

The Secretary presented a number of designs for the proposed Society emblem. It was decided to accept a design submitted by J. E. Caldwell & Co., and to enter upon a contract with that firm to supply these badges to properly certified members of the Society at a fixed price.

The Secretary presented letters from Mr. W. M. Corse and Mr. H. E. Smith, recommending that the annual meetings be occasionally held at some point, such as Niagara Falls, further west than Atlantic City. After careful consideration it was decided to hold the next annual meeting at Atlantic City.

The Secretary presented a statement covering proposed arguments for and against adherence to the present regulations by which representatives of producing interests are debarred from the chairmanships of technical committees. In that connection he also presented letters from Messrs. J. A. Capp, Richard Moldenke, C. E. Skinner, G. W. Thompson and Walter Wood. It was decided that the preparation of the final draft of these arguments should be left to a committee consisting of the President, Mr. Moldenke and the Secretary, with the understanding that if the latter two should not be able to reach an agreement the President's decision should be final. The Secretary was also instructed to prepare a statement covering the complete history of this matter, as an introduction to the statement relating to the pros and cons, in submitting the question to the vote of the membership at large.

The President presented a verbal report on the August meeting of the Council of the International Association with special reference to the action affecting International specifications.

It was the sense of the meeting that the proposed appointment of two separate International committees on steel and cast iron was a step in the right direction, and it was decided to nominate, in due course, Mr. W. A. Bostwick and Mr. W. R. Webster as the American representatives on Steel, and Mr. Richard Moldenke and Mr. Walter Wood as the American representatives on Cast Iron.

The Secretary reported that it had been decided to hold the 1912 Congress of Applied Chemistry in this country during the first half of September, and that an opening session was to be held in Washington and the following sessions, for the most part, in New York.

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The creation of an Organizing Committee for the 1912 Congress of the International Association for Testing Materials was discussed and the Secretary was instructed to proceed with the development of general plans for the organization of such a committee.

REGULAR MEETING, January 17, 1911.—Engineers' Club, Philadelphia, Pa. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. James Christie and Mr. W. R. Webster, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported the receipt of 68 applications for membership, duly approved, the resignation of 15 members, and the loss by death of 2 members, namely, Mr. Nelson A. Hallett, August 9, 1910, and Mr. Mace Moulton, April 27, 1909, making the total membership on January 1, 1911, 1,321.

The Treasurer presented a report from John Heins & Co., Public Accountants and Auditors, dated January 4, 1911, to the effect that they had made "an audit and examination of the books and accounts of the Society for the six months ending December 31, 1910, and report them to be correctly and carefully kept."

The Secretary reported the following inventory of Proceedings:

	Binding.			
	Paper.	Cloth.	Leather.	Total.
Volume I	98	62	27	187
" II	114	62	28	204
" III	17	60	29	106
" IV	146	60	24	230
" V	348	64	29	441
" VI	675	52	30	757
" VII	409	60	34	503
" VIII	428	55	29	512
" IX	434	144	59	637
Total	2,669	619	289	3,577

It was decided that the sale of any given volume shall be discontinued, except as a part of a complete series of volumes, as soon as the number of remaining copies on hand is reduced to one hundred.

The Secretary was authorized to furnish additional copies of the Year-Book to members at the special price of $3.00.

The Secretary presented the following report from the tellers who canvassed the vote relating to the paragraph affecting the permanent chairmanship of technical committees: Affirmative votes 189, negative votes 67, irregular 1, total 257. Dated December 20, 1910, signed by Mr. Henry H. Quimby and Mr. W. Purves Taylor, Tellers.

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The Secretary presented a letter under date of December 1, 1910, from Mr. R. K. Johnson, Chairman of Committee A-10, advising the Executive Committee of the willingness of that Committee to continue as an active body.

The Secretary reported progress in connection with the organization of Committee A-2 on Standard Specifications for Wrought Iron, and it was decided to invite Mr. J. Allen Colby to accept the temporary chairmanship of that Committee.

The Secretary presented correspondence with Mr. C. W. Boynton, recommending the appointment of a committee on Standard Tests and Specifications for Drain Tile. On motion the creation of such a committee was authorized. The Secretary was instructed in that connection to recommend to this committee, on behalf of the Executive Committee, that first attention be given to standard specifications governing the tests of tile, and that definite recommendations with respect to standard specifications for the product itself be deferred pending the collection of sufficient data to safely warrant such action.

It was decided to authorize the creation of a Committee on "The Definition of the Term 'Modulus of Elasticity' in its Application to Materials, including Non-Ferrous Metallic Metals and their Combinations." The Secretary was instructed to invite Mr. Leonard Waldo to accept the temporary chairmanship of this committee.

The Secretary was authorized to merge for the present any receipts from life membership dues with the general funds of the Society. It was also decided to take no active steps towards inviting corporations to acquire membership in perpetuity.

The Secretary announced the appointment by the International Association of Mr. Charles W. Burrows as referee on Problem 28 on "The Consideration of the Magnetic and Electric Properties of Materials in Connection with their Mechanical Testing."

The Secretary presented some correspondence with the Secretary of the International Association relative to preliminary plans for the Sixth Congress of that Association It was decided that the nucleus of the Committee on Organization for that Congress shall consist of the members of the Executive Committee and the officers of the standing technical committees, and that the first meeting of this Committee shall be held in New York in February, 1911, at a time to be fixed by the President.

The Secretary called attention to the recommendation, made about a year ago, by International Committee Ia (since enlarged to include Committees Ia and Ib) that the sum of 3,000 Marks per annum should be made available by contributions in equal parts by the American Society for Testing Materials, the Deutscher Verband, and the Engineering Standards Committee.

The Secretary was authorized to inform Mr. Rieppel, the Chairman of that Committee, and Mr. Reitler, the Secretary of the International Association, that the American Society is prepared to make such a contribution for the current year, provided (1) that this fund is still needed by

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the Committee, and (2) that the other two above-mentioned organizations will obligate themselves to make like contributions.

REGULAR MEETING, May 9, 1911.—Engineers' Club, Philadelphia, Pa. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. James Christie and Mr. W. R. Webster, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported the receipt of 60 applications for membership, duly approved and the resignation of 42 members, making the total membership on April 1, 1911, 1,339.

The Secretary also reported that 86 members were in arrears for dues from August 1, 1910. The Secretary was instructed to inform the members in arrears that if their indebtedness to January 1, 1911, is not paid by July 1, 1911, their names will be dropped from the membership roll.

The Secretary reported that he had solicited estimates on the printing of the Proceedings from five leading Philadelphia publishers, two of whom were unable to meet the requirement of monotype rather than linotype composition. The bids of the remaining three were presented in detail and the Secretary's action, on the basis of these estimates, in renewing the printing contract for the current year with The John C. Winston Company, was approved.

The Secretary reported the purchase, by provisional authority of the President, of an addressograph machine at a cost of $124.34. This action was approved.

The Secretary presented a copy of the formal agreement with J. E. Caldwell & Co., for the manufacture and sale of the official badge of the Society, which was on motion approved.

The Secretary called attention to the necessity of amending the by-laws in certain particulars (see above report of Executive Committee) and he was instructed to take the necessary steps in the matter.

The Secretary presented a communication from Mr. C. E. Skinner, recommending that an effort be made to bring about greater uniformity in the general form of specifications issued by the Society. The Secretary was authorized to inform Mr. Skinner that a special meeting of the chairmen of the technical committees concerned with the preparation of specifications will be called at a convenient time during the annual meeting, provided that he will agree to be present at that meeting with a view of indicating his recommendations in their bearing on existing specifications in as much detail as he may find possible.

The Secretary presented a copy of a letter, under date of March 17, 1911, from Mr. Lesley S. Robertson, Secretary of the British Engineering Standards Committee, to Mr. Ernst Reitler, Secretary of the International Association for Testing Materials, to the effect that "while the Engineering Standards Committee is willing and desirous of assisting the International Association for Testing Materials in the admirable work being carried on by them, the Committee greatly regret that they are not in a

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position to divert the funds subscribed for work under their direct control to channels outside and beyond that control."

This communication was received in response to the proposal of the Executive Committee of the American Society to the International Association (see abstract of minutes of meeting held on January 17, 1911) to subscribe the sum of 1,000 Marks.

The Secretary was authorized to inform the Secretary of the International Association of the willingness of the American Society to reaffirm this proposal without reference to the Engineering Standards Committee.

Appointments of five members each were made on the following committees of the Organizing Committee of the Sixth Congress of the International Association for Testing Materials:

(*a*) Finance Committee.
(*b*) Committee on Papers.
(*c*) Committee on Transportation.
(*e*) Committee on Information.
(*f*) Reception Committee.
(*g*) Local Committee.

Appointments on the following committees were deferred:

(*d*) Committee on Excursions.
(*h*) Ladies Committee.

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SOCIETY EMBLEM.

The Society Emblem, adopted in 1910, is shown above full size. The letters are in gold on a black enameled background. The emblem mounted on a disk for use as a fob charm is shown below in full size.

The Executive Committee has made an exclusive arrangement for the manufacture and sale of the emblem to members of the Society with the firm named below, with whom orders may be placed direct at the following prices:

PRICE LIST.

I. Gold badge, with pin and safety catch	$3 50
(*a*) With initials and year of membership engraved on back without extra charge.	
(*b*) With full name engraved on back and year of membership at an extra charge of	25
II. Gold fob charm with emblem mounted on disk	9 50
(*a*) With initials and year of membership engraved on back without extra charge.	
(*b*) With full name and year of membership engraved on back without extra charge.	
III. Gold bail and silk ribbon for watch fob, complete	4 00

NOTE.—Orders under I or II should include explicit reference to directions (*a*) or (*b*). Orders should be directed to J. E. Caldwell and Company, 902 Chestnut Street, Philadelphia, Pa.



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Bulletin No. 5. Preliminary Report on the Present State of Knowledge Concerning Impact Tests, by Professors W. Kendrick Hatt and Edgar Marburg. October, 1899. Pp. 27–52.

Bulletin No. 6. Report of Second Annual Meeting, August 15–16, 1899. Minutes of the Executive Committee to August 16, 1899. November 1899. Pp. 53–72.

Bulletin No. 7. Minutes of the Executive Committee to January 6, 1900. Miscellaneous Announcements. January, 1900. Pp. 73–80.

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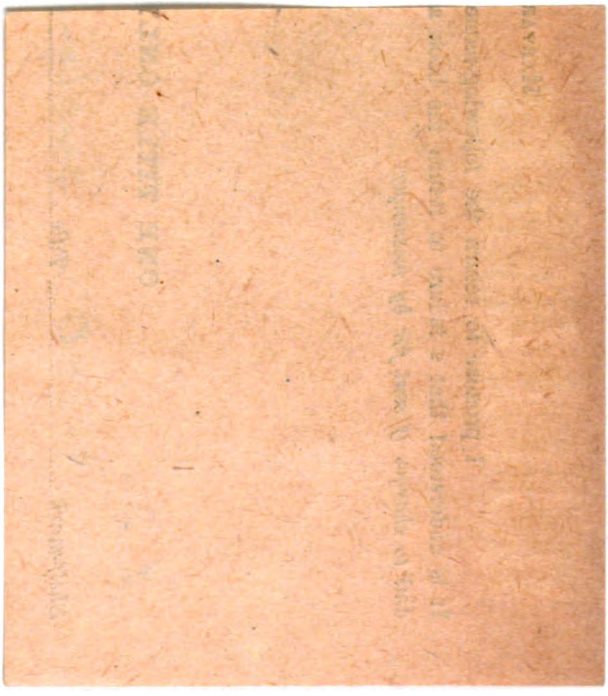
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